FINAL REPORT
GEOTECHNICAL INVESTIGATION
WATER LINE REPLACEMENT
IN SPRING WOODS SOUTH AREA
WBS NO. S-000035-0181-4
HOUSTON, TEXAS

PREPARED BY

ASSOCIATED TESTING LABORATORIES, INC.

HOUSTON, TEXAS

ATL REPORT NO. G13-165

July 17, 2014

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July 17, 2014

ATL Job No: G13-165

Van De Wiele & Vogler, Inc.
2925 Briarpark, Suite 275
Houston, Texas 77042-3720

Attention: Mr. Michael Martin, P.E.

Reference: Final Geotechnical Investigation Report
Proposed Water Line Replacement in Spring Woods South Area
WBS No. S-000035-0181-4
Houston, Texas

Dear Mr. Martin:

We have completed the report for the geotechnical investigation for the above-referenced project. Our findings, geotechnical engineering analyses and recommendations are presented in this report.

It has been a pleasure working with you on this project. Should you have any questions concerning this project work, please call us at (713) 748-3717.

Sincerely,

ASSOCIATED TESTING LABORATORIES, INC.

STATE OF TEXAS
PENG SIA TANG
81150
REGISTERED
PROFESSIONAL ENGINEER
7/17/14

Peng Sia Tang, P. E.
Manager, Geotechnical Services

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President

GEOTECHNICAL INVESTIGATION

WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA

HOUSTON, TEXAS

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HOUSTON, TEXAS

EXECUTIVE SUMMARY

Associated Testing Laboratories, Inc. (ATL) has completed the geotechnical study for the proposed replacement of existing water lines in the Spring Woods South Area, as shown in Figure 1. The project entails replacing approximately 23,190 LF of existing water lines with new 6-, 8- and 16-inch diameter water lines, at depths ranging from about 6 to about 14 feet below existing grade (see Figures 2a through 2c).

Trenchless installation technique will mostly be employed. Open cut/trench excavation will be carried out at access pits (auger pits), and possibly in local areas where underground obstructions or site conditions warrant open cut/trenching. The subsurface conditions investigated by 37 soil borings (to 12 to 20 feet below existing grade) along the project alignments, consists predominantly of Lean Clays (CL) with some Clays (CH) of soft to hard consistency. Silty-Clayey Sand (SC-SM), Poorly Graded Sand with SIlty (SP-SM) and Silty Sand (SM) stratum were found in the following borings: B-1 (2 to 8 feet, and 12 to 16 feet), B-4 (to 4 feet); B-5 (to 2 feet); B-7 (14 to 20 feet); B-8 (to 2 feet, 14 to 16 feet); B-9 (to2 feet); B-10 (to 2 feet, 14 to 16 feet); B-15 (to 2 feet); B-16 (to 4 feet); B-19 (12 to 14 feet); B-21 (10 to 13.5 feet); B-22 (12 to 15.5 feet); B-23 (14 to 15.5 feet); B-24 (14 to 15.5 feet); B-28 (to 2 feet, 14 to 15.5 feet); B-29 (to 2 feet); B-30 (to 4 feet); B-32 (to 2 feet); B-33 (to 2 feet, 12 to 15.5 feet); B-34 (to 2 feet); B-35 (12 to 14 feet); B-37 (to 2 feet). Detailed subsurface soils and stratigraphy are shown in the individual boring logs in Appendix 3 and in the Boring Log Profiles in Figures 4a through 4n.

Groundwater was not encountered in any of the 37 borings during and at completion of drilling. Borings B-1, B-4 and B-10 were converted into Piezometer PZ-1 through PZ-3 after completion of

drilling and soil sampling. PZ-1 through PZ-3 were dry 24 hours after installation, as well are after 7 and 30 days.

Our main geotechnical findings and recommendations are summarized below:

1. No unusual staining or hydrocarbon-like odor was noted in the soil samples recovered from the soil borings drilled in ATL's geotechnical investigation.
2. A preliminary fault evaluation based on review of available fault maps and literature review indicated that the documented Long Point Fault is estimated to be about 0.15 miles south-southeast of the project site. A Phase I fault evaluation by a Professional Geologist knowledgeable is not recommended at this time.
3. Based on proposed flow line depths and the subsurface conditions (see Figures 4a through 4n), the water line installation excavations will be advanced mostly in stiff to very stiff clays with local stratum of soft to firm clays. However, granular soils or soils with limited cohesion will likely be present at locations (but not limited to) identified in Table C of Section 5.2, or at locations away from the locations investigated in this project.
4. Based on the proposed invert elevation and the gathered groundwater information, the water line construction excavations will not likely to encounter groundwater. However, it should be noted that groundwater level will fluctuate with the amount of precipitation prior to and during the construction.
5. Geotechnical parameters/information and construction recommendations for the proposed open cut/trenching and trenchless installation of the proposed water lines are presented in Section 5. Construction considerations are provided in Section 6.

GEOTECHNICAL INVESTIGATION
WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
HOUSTON, TEXAS

1.0 INTRODUCTION

1.1 General

The geotechnical investigation for Water Line Replacement in Spring Woods South Area was authorized via the Professional Services Agreement executed on May 23, 2013, and with the acceptance of the **Associated Testing Laboratories, Inc., (ATL)** Proposal No. CP12-0902R2 dated April 26, 2013. Project details were provided to ATL by Van De Wiele & Vogler, Inc. (VDW&V). This report includes results of the field investigation, laboratory testing, geotechnical engineering analysis and recommendations for the proposed water line replacement for this project.

1.2 Location and Description of the Project

The project sites of this project are located in a mixed residential and commercial neighborhood, a Site Vicinity Map showing the project alignments is presented in Figure 1. Photographs of the project sites were taken at the time of our site visit, and some are presented in Appendix 1.

The project entails replacing the existing water lines with approximately 23,190 linear feet of 6-, 8- and 16-inch diameter water lines in the Spring Woods South Area in the City of Houston, Texas. The project alignments traverse streets in the Key Map 450 S and W area, and are shown in Figures 2a through 2c.

The approximate invert depths of the proposed water lines at the proposed boring locations, based on information provided by VDW&V, range from about 6 to about 14 feet below existing grade.

Trenchless installation technique will mostly be employed. There is no ditch, creek or bayou crossing in this project.

1.3 <u>Scope of Work</u>

A geotechnical investigation was conducted to determine subsurface soil conditions along the proposed project alignments and to develop geotechnical engineering recommendations for the construction of new underground utilities consisting of water lines. **Associated Testing Laboratories, Inc. (ATL)** has completed a subsurface exploration program for this project consisted of the following scope:

- Augering through existing pavements at borings located within streets with asphaltic concrete (AC) pavements using the drill rig auger.
- Original scope of drilling and sampling entails a total of thirty seven (37) borings (Borings B-1 through B-37), to depths ranging from 12 to 19 feet below existing grade, for a total of 531 lineal feet of drilling, and converting three borings into piezometers (totaling 53 lineal feet) after completion of drilling and sampling. The actual drilling footage, with the extension of select soil borings where sands were encountered at the bottom of boring (per City of Houston Design Guide), entails 37 borings drilled to depths of 12 to 20 feet below existing grade, for a total of 544 lineal feet.
- Conducting laboratory tests on selected soil samples recovered from the soil borings.
- Developing boring logs and boring log profiles to present the general subsurface soil and groundwater conditions.
- Conducting a preliminary fault review of the project area based on review of available fault maps and literature.

Based on results from the field investigation, laboratory testing and gathered geological information, ATL performed geotechnical analyses to develop geotechnical recommendations for the proposed water lines replacement construction.

2.0 SUBSURFACE INVESTIGATION PROGRAM

The field investigation for this project consisted of drilling and sampling a total of thirty seven (37) soil borings and installing three (3) piezometers along the project alignments. The boring/piezometer locations and depths were approved during the proposal phase. The proposed borings and piezometers were selected based on criteria for borings and piezometers specified in City of Houston Department of Public Works and Engineering Design Manual, Chapter 11 "Geotechnical and Environmental Requirements".

The majority of the 37 boring locations were located within existing asphaltic concrete (AC) pavements, and ten are located within existing portland cement concrete pavements (PCC) pavements. The existing PCC pavements at boring locations were cored through using a pavement coring machine, and the AC pavements were augered through using the drilling rig auger. The information from our boring/piezometer and depths and the coordinates (northing and easting) are presented in the table below.

TABLE A: BORING AND PIEZOMETER INFORMATION

Boring		Piezometer		Location	Northing	Easting
No.	Depth, ft.	No.	Depth, ft.			
B-1	17	PZ-1	17	Neuens Rd.	13,858,213.98	3,064,441.35
B-2	17	--	--	Neuens Rd.	13,858,223.07	3,064,745.25
B-3	18	--	--	Neuens Rd.	13,858,243.96	3,065,420.09
B-4	19	PZ-2	19	Witte Rd.	13,858,116.72	3,065,842.77
B-5	17	--	--	Witte Rd.	13,857,590.25	3,065,866.99
B-6	15	--	--	Witte Rd.	13,856,978.99	3,065,891.47

Boring		Piezometer		Location	Northing	Easting
No.	Depth, ft.	No.	Depth, ft.			
B-7	20	--	--	Witte Rd.	13,856,513.24	3,065,910.64
B-8	17	--	--	Witte Rd.	13,855,994.62	3,065,932.06
B-9	16	--	--	Witte Rd.	13,855,446.75	3,065,955.14
B-10	17	PZ-3	17	Witte Rd.	13,854,445.28	3,065,996.96
B-11	14	--	--	Long Point Rd.	13,853,997.74	3,065,753.30
B-12	12	--	--	Long Point Rd.	13,853,990.35	3,065,346.43
B-13	15	--	--	Long Point Rd.	13,853,978.30	3,064,658.36
B-14	13	--	--	Timberwood Dr.	13,857,291.93	3,064,780.67
B-15	13	--	--	Southwick St.	13,857,622.20	3,065,139.04
B-16	13	--	--	Hollow Hook Rd.	13,857,180.04	3,065,455.11
B-17	13	--	--	Timberoak Dr.(E)	13,856,987.93	3,064,546.20
B-18	13	--	--	Timberoak Dr.(E)	13,856,993.65	3,064,952.87
B-19	17	--	--	Haddington Dr.	13,856,683.05	3,064,569.13
B-20	12	--	--	Haddington Dr.	13,856,711.10	3,065,200.53
B-21	13.5	--	--	Haddington Dr.	13,856,712.93	3,065,525.22
B-22	15.5	--	--	Warwana Rd.	13,856,390.84	3,064,584.04
B-23	15.5	--	--	Warwana Rd.	13,856,403.07	3,065,472.69
B-24	15.5	--	--	Briarwild Ln.	13,856,107.32	3,064,829.81
B-25	14	--	--	Briarwild Ln.	13,856,091.59	3,065,304.91
B-26	14	--	--	Lazy Oaks St.	13,855,756.09	3,064,612.48
B-27	14	--	--	Lazy Oaks St.	13,855,767.80	3,065,170.06
B-28	15.5	--	--	Lazy Oaks St.	13,855,773.91	3,065,575.32
B-29	12	--	--	Hazelhurst Dr.	13,855,182.42	3,064,640.47
B-30	15	--	--	Hazelhurst Dr.	13,855,190.71	3,065,120.72
B-31	12	--	--	Whiteside Ln.	13,854,929.32	3,064,922.37
B-32	12	--	--	Whiteside Ln.	13,854,939.41	3,065,419.76
B-33	15.5	--	--	Witte Rd.	13,854,948.08	3,065,946.07
B-34	13	--	--	Longhorn Dr.	13,854,479.96	3,064,883.07
B-35	14	--	--	Hanka Dr.	13,854,664.97	3,065,520.22
B-36	12	--	--	Timberoak Dr.	13,856,816.46	3,061,683.51

Boring		Piezometer		Location	Northing	Easting
No.	Depth, ft.	No.	Depth, ft.			
B-37	13	--	--	Haddington Dr.(W)	13,856,551.32	3,062,844.37

Boring locations drilled in this geotechnical exploration are shown on Figures 2a through 2c. The boreholes were drilled dry to the bottom of the boring or to a depth where a borehole started caving in, after which rotary wash boring technique was carried out. In cohesive soils, undisturbed soil samples were collected using a conventional 3-inch O.D. Shelby tube in accordance with ASTM D1587. Cohesionless soils were sampled using split spoon sampler in accordance with ASTM D1586. All soil samples were examined, classified and logged in the field. A representative portion of each sample was packed in containers to prevent moisture loss. All soil samples were properly labeled and subsequently transported to the ATL laboratory.

Boring B-1, B-4 and B-10 were converted into piezometer PZ-1 through PZ-3 after the completion of drilling and sampling. The groundwater level information encountered in the boreholes during and at completion of drilling, and the water level in the piezometer after 24 hours, 7 and 30 days are presented in Table 2. The piezometers were pulled and plugged with cement-bentonite grout after the 30-day water level reading. The piezometer installation reports are presented in Appendix 2.

Upon completion of drilling, the borings where no piezometer was to be installed were backfilled using cement-bentonite grout using a tremie. The cored PCC pavements were patched using portland cement concrete, and the augered AC pavements were patched using cold-mixed asphaltic concrete.

All soil samples were classified according to Unified Soil Classification System (ASTM D-2487). The soil and groundwater information found in each boring are shown on the individual boring logs presented in Appendix 3. A Key to Log Terms and Symbols is also presented in Appendix 3.

3.0 LABORATORY TESTING PROGRAM

Samples obtained from the field were again examined and classified in our laboratory by the geotechnical technician under the supervision of an engineer. Laboratory testing was performed on selected soil samples collected during the field investigation. The laboratory testing program included Atterberg Limits (ASTM D-4318), Density, Moisture Content (ASTM D-2216), Unconfined Compressive Strength (ASTM D-2166), Unconsolidated Undrained Triaxial (ASTM D-2850) and Percent Finer Than No. 200 Sieve (ASTM D-1140) tests. The results of laboratory tests are presented in the boring logs in Appendix 3 and summarized in Table 3. Overall numbers and types of tests performed for this study for this project are presented below:

TABLE B: SUMMARY OF LABORATORY SOIL TESTS

TYPE OF TEST	NUMBER OF TEST
Dry Density	43
Moisture Content	282
Atterberg Limits	76
Unconsolidated Undrained Triaxial	8
Sieve Analysis thru #200	63
Unconfined Compression	35

4.0 SUBSURFACE AND SITE CONDITIONS

4.1 Geology of Coastal Plain

The proposed project area is located within the Gulf Coast Structural Province, a huge sedimentary basin containing several thousand feet of sediments. In general, these sediments consist of loose sands, silts and clays which slope gently toward the Gulf of Mexico.

The project site located is underlain by the Lissie Formation of Pleistocene age. The Lissie Formation consists of sand, silt, clay, and minor amount of gravel. Iron oxide and iron-manganese nodules common in zone of weathering and contains locally calcareous material. The surface is fairly flat and featureless except for many shallow depressions and pimple mounds. The surface materials are often weakened by the weathering process.

4.2 Geologic Faults

Among the geologic and geomorphological features in this region are sedimentary deposits broken by structure such as normal faults, salt domes, etc. The sedimentary deposits slope gently toward the Gulf of Mexico. They are broken by normal faults, most of which dip toward the Gulf and extend downward many thousands of feet. The earth movements that caused these faults took place within the last 50,000 years. In general, the regional faults in the Houston area trend parallel to the Gulf Coast. Only the local faults over the salt domes show a radial pattern associated with the upthrust of the salt mass. There are numerous faults and fault systems in the Greater Houston and surrounding area. The movements of many of these faults has been affected in recent history by area subsidence. The subsidence is theorized to have been associated with the removal of oil and groundwater. As much as nine (9) feet of subsidence has occurred in the area east of Houston in the last 70 years. Conversion to surface water usage and the limiting of oil production has greatly reduced the subsidence rate in the area east of Houston.

Figure 3 shows the Lidar (Light Detection and Ranging) imagery of the Long Point Fault (Source: USGS 2004). Based on interpretation of the preceding information, the Long Point Fault is estimated to locate about 0.15 miles south-southeast of the project area. Therefore, ATL does not recommend a Phase I Geological Fault Study. It should be noted that the preceding information is based on known and documented fault information and published fault maps, and the possibility of presence of heretofore-undiscovered faults or unknown faults that do not make surface manifestation exist. If additional information regarding the Long Point Fault and the area geological faulting is desired, a Professional Geologist knowledgeable in geological faulting of Houston-Harris County should be consulted.

4.3 Subsurface Soil Stratigraphy and Geotechnical Characterization

***Existing Pavement Material*:** Twenty seven (27) of the 37 borings were located in existing streets with AC pavements, and ten (10) were located in existing streets with PCC pavements. The PCC pavements were cored through using a pavement coring machine, and AC pavements were drilled through using the drilling rig auger. A summary of the existing pavement sections encountered at each boring location is presented in Table 1.

Based on the pavement information gathered from our field investigation, the existing PCC pavements at the boring locations have thicknesses ranging from about 5.5 to 8.5 inches, and with about 3 inches of stabilized shell base at one location. The existing AC pavements consist of about 1 to 9 inches of AC surface and underlain by about 2 to 11 inches of base consisting of gravel, crushed stone, shell and stabilized shell. The AC pavement material and thicknesses were estimated from the cuttings from the drill rig auger. The actual pavement material and thicknesses in the field, at or near the boring locations, may differ from those described in the Table 1.

***Potentially Hazardous Materials*:** No unusual staining or hydrocarbon-like odor was noted in the soil samples recovered from the soil borings drilled in ATL's geotechnical investigation.

***Subsurface Soil Stratigraphy*:** Based on our soil borings, the subsurface soils along the project alignments consists generally of following:

Along Neuens Road (Profile 4a): The subsurface soils below the existing AC pavements, as found in Borings B-2 and B-3, consist of firm to hard Lean Clays (CL); the top 8 feet of the clay soils in Boring B-2 are fill. In Boring B-1, Lean Clay fill was found below the AC pavements to a depth of about 2 feet, and it is underlain by loose to medium dense Silty Sand (SM) fill to a depth of about 8 feet. The Silty Sand is underlain by a stratum of soft to firm Lean Clays (CL) with sand lenses to a depth of about 12 feet, followed by another stratum of loose to medium dense Silty Sand (SM) to a depth of 16 feet. Below the Silty Sand stratum, hard Lena Clay CL) was found to the bottom of boring at 17 feet.

<u>Along Witte Road – 1 o 2 (Profile 4b)</u>: The subsurface soils below the existing AC pavements consist predominantly of soft to very stiff Lean Clays (CL) to the bottom of Borings B-4 through B-6 and B-8 at 15 to 20 feet below existing grade. In Boring B-7, firm to very stiff Lean Clays (CL) were found to a depth of about 14 feet, and underlain by a stratum of medium dense Silty Sand (SM) to the bottom of Boring B-7 at 20 feet; in Boring B-8, stiff to very stiff Lean Clays (CL) were found to a depth of about 14 feet, and underlain by a2-foot stratum of firm Silty –Clayey Sand (SC-SM, followed by very stiff Le an Clays (CL) to the bottom of Boring at 17 feet. Silty-Clayey Sand (SC-SM) and Silty Sand (SM) was found below the AC pavements to a depth of about 2 to 4 feet in Borings B-4, B-5 and B-8.

<u>Along Witte Road – 2 of 2 (Profile 4c)</u>: A stratum of Silty Sand (SM) was found below the existing AC pavements and exists to a depth of about 2 feet. The subsurface soils below the existing AC pavements consist predominantly of stiff to hard Lean Clays (CL), to the bottom of Boring B-9 at 16 feet below grade,. In Boring B-33, hard Lean Clays (CL) exist to a depth of about 12 feet, and is underlain by a stratum of medium dense Silty Sand (SM). In Boring B-10, firm to very stiff Lean Clays (CL) were found to a depth of about 14, followed by a 2-foot stratum of medium dense Silty Sand (SM) and then by a layer stiff Lean Clay (CL) to the bottom of boring at 17 feet.

<u>Along Long Point Drive (Profile 4d)</u>: The subsurface soils below the existing PCC pavements consist of firm to hard Lean Clays (CL) to the bottom of Borings B-11 through B-13 at depths

ranging from 12 to 15 feet below existing grade.

<u>Along Timberwood Drive (Profile 4e)</u>: The subsurface soils below the existing AC and PCC pavements consist of very stiff to hard Lean Clays (CL) to the bottom of Borings B-14 a
to B-16 at 13 feet below existing grade. A stratum of Silty Sand (SM) and Silty-Clayey Sand (SC-SM) was found below the existing pavements and exists to a depth of about 2 feet in Boring B-15 and B-16.

<u>Along Timber Oak Drive (E) (Profile 4f)</u>: The subsurface soils below the existing PCC pavements consist soft to very stiff Lean Clays (CL) that exist to a depth of 13 feet below the existing grade in Borings B-17 and B-18.

<u>Along Haddington Drive (E) (Profile 4g)</u>: The subsurface soils below the existing AC and PCC pavements consist predominantly of soft to hard Lean Clays (CL) to the bottom of Boring B-20 at 12 feet, and to a depth of about 12 and 10 feet in Boring B-19 and B-21, respectively, and underlain by a stratum of medium dense Silty Sand (SM) to a depth of about 14 and 13.5 (bottom of boring) feet, respectively. In Boring B-19, the Silty Sand (SM) is underlain by a stratum of very stiff LeanClays (CL) to the bottom of boring at 17 feet.

<u>Along Warwana Road (Profile 4h)</u>: The subsurface soils below the existing AC pavements consist of firm to hard Lean Clays (CL) that exist to a depth of about 12, 14 and 14 feet in Boring B-22, B-23 and B-7, respectively, and underlain by a stratum of loose to medium dense Silty Sand (SM) to the bottom of boring at 15.5, 16 and 20 feet, respectively.

<u>Along Briarwild Lane (Profile 4i)</u>: The subsurface soils below the existing AC pavements consist of firm to hard Lean Clays (CL) to the bottom of Boring B-25 at 14 feet, and to a depth of about 14 feet in Boring B-24 and B-8. The Lean Clay stratum is underlain by a stratum of medium dense Poorly-Graded Sand with Silt (SP-SM) to the bottom of Boring B-24 at 15.5 feet. In Boring B-8, the

Lean Clay stratum is underlain by a2-foot stratum of firm Silty-Clayey Sand (SC-SM), followed by a stratum of very stiff Lean Clay (CL) to the bottom of boring at 17 feet.

Along Lazy Oak Street (Profile 4j): The subsurface soils below the existing AC pavements consist predominantly of firm to very stiff Lean Clays (CL) to the bottom of Boring B26 and B--27 at 14 feet, and to a depth of about 14 feet in Boring B-28 and followed by a stratum of medium dense Silty Sand (SM) to the bottom of boring at a depth of 15.5 feet.

Along Hazelhurst Drive (Profile 4k): The subsurface soils below the existing AC pavements in Borings B-29 and B-30 consist of a stratum of Silty Sand (SM) that exist to a depth of about 2 and 4 feet, respectively. The Silty Sand stratum is underlain by a stratum of very stiff to hard Lean Clays (CL) to the bottom of boring at 12 and 15 feet, respectively.

Along Whiteside Lane (Profile 4l): The subsurface soils below the existing AC pavements consist of predominantly of stiff to hard Lean Clays (CL) that exist to bottom of Borings B-31 and B-32 at 12 feet, and to a depth of about 12 feet in Boring B-33. The lean clay stratum is underlain by medium dense Silty Sands (SM) to the bottom of Boring B-33 at 15.5 feet.

Along Hanka Drive (Profile 4m): The subsurface soils below the existing AC pavements consist predominantly of very stiff to hard Lean Clays (CL) to the bottom of Boring B-34 at 13 feet, and to a depth of about 12 feet in Boring B-35, followed by a stratum of medium dense Silty Sand (SM) to the bottom of Boring b-35 at 14 feet.

Along Timberoak Drive (W) / Haddington Dr. (W) (Profile 4n): The subsurface soils below the existing subgrade and the PCC pavements consist of very stiff to hard Lean Clays (CL) to the bottom of Borings B-36 and B-37 at 12 and 13 feet below existing grade. Borings B-28, B-30 and B-32 conducted by Aviles Engineering Corporation in 2007 revealed similar subsurface conditions.

The detailed subsurface soils and stratigraphy are shown in the individual boring logs in Appendix 3 and in the Boring Log Profiles in Figures 4a through 4n. “CL”, “CH”, “SC-SM” and “SM” are classes of soils described in the Unified Soil Classification System.

The lean clays (CL) found in the soil borings have liquid limits ranging between about 23 and 49%, and plasticity indices (PI) ranging between about 8 and 30%. Clean non-expansive sandy lean clay soils (plasticity index between about 10 and 20) can be used as select fill in their present condition. The fat clay (CH) soils found in the soil borings have liquid limits ranging between about 50 and 59%, and plasticity indices ranging between about 31 and 39%. High plasticity fat and lean clays (PI>20) are not suitable for use as select fill in their present condition; however, these soils in their present conditions may be used as random fill. High plasticity clay soils, if clean, can be treated with appropriate amount of lime and used as select fill; a lime dosage of 6% by weight is recommended for preliminary estimate purposes, but lime vs. pH and/or lime vs. PI series tests should be conducted to determine the optimum lime dosage.

4.4 <u>Groundwater</u>

Groundwater was not encountered any of the 37 borings during and at completion of the drilling. Borings B-1, B-4 and B-10 were converted into Piezometer PZ-1 through PZ-3 after completion of drilling and soil sampling. PZ-1 through PZ-3 were dry 24 hours after installation, as well as after 7 and 30 days.

The groundwater information encountered during and at the end of drilling in the boreholes, and in the piezometer after 24 hours and 7 and 30 days are presented in Table 2. It should be noted that the groundwater conditions will fluctuate according to the amount of precipitation and the environments conditions at the site.

Perched water table may exist in permeable sand/silt lenses/seams/layers within clay stratum that can form pathways for percolated and infiltrated water. The rate of flow of groundwater produced by these layers will depend upon the weather conditions such as locations of size and continuity of the permeable layers/seams/lenses, and the amount of precipitation and ambient temperature etc., at the time of construction.

5.0 GEOTECHNICAL ANALYSES AND RECOMMENDATIONS

The proposed water line installation will likely involve augering, one of many trenchless construction technique. Construction of access pits (auger pits) will likely involve open cut/trench excavation; it is also possible that open cut/trenching construction may be carried out in local areas where underground obstructions or site conditions warrant the construction technique. Based on the plan and profile drawings, the water lines are proposed to be installed at depths ranging between about 6 and 14 feet.

5.1 OSHA Soil Types

At the federal level, Occupational Safety and Health Act (OSHA) requires protective systems for all trenches exceeding 5 feet in depth. OSHA has developed a soil classification system to be used as a guideline in determining sloping and protective system requirements for trench excavations. This system has set forth a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing amounts of stability.

Stable Rock: Natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Type A: Cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) or greater.
However, no soil is Type A if:

- The soil is fissured; or
- The soil is subject to vibrations from heavy traffic, pile driving, or similar effects; or
- The soil has been previously disturbed; or
- The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four (4) horizontal to one (1) vertical or greater; or
- The material is subject to other factors that would require it to be classified as a less stable material.

Type B:
- Cohesive soil with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf; or
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
- Dry rock that is not stable; or
- Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C:
- Cohesive soil with an unconfined compressive strength of 0.5 tsf or less; or
- Granular, including gravel, sand, and loamy sand; or
- Submerged soil or soil from which water is freely seeping; or
- Submerged rock that is not stable;. or
- Material is a sloped, layered system where the layers dip into the excavation on a slope of four (4) horizontal to one (1) vertical or steeper.

Based on the soil conditions from the borings and groundwater information from the borings and piezometers, ATL recommends classifying the top 10 feet of the onsite clay soils (CL/CH) that are soft to firm as OSHA Soil Type "C", and those that are stiff to hard as OSHA Soil Type "B" for the determination of allowable maximum slope or selection and design of the protective system. All onsite clay soils below a depth of 10 feet shall be classified as OSHA Soil Type "C". Fill soils, sands (SP/SM/SC), silts (ML), silty clays (CL-ML) and any soils subject to hydraulic pressure or vibrations shall be classified as OSHA Soil Type "C".

5.2 Open Cut/Trench Excavation

The proposed water line installation will involve construction using trenchless techniques. However, construction of auger pits for the proposed water line installation will involve open cut/trench excavation, it is also possible that open cut and trenching may be carried out in local areas where underground obstructions or site conditions warrant such a construction technique.

The approximate flow line depths and the subsurface conditions found in the soil borings are shown in the Boring Log Profiles on Figures 4a through 4n. Accordingly, the water line installation excavation will be advanced mostly in stiff to hard clays (CL/CH), with local soft to firm stratum. However, locations identified in Table C below (but not limited to) may encounter granular soils during the construction excavation:

TABLE C: LOCATIONS WHERE WATER LINE INSTALLATION MAY ENCOUNTER SANDS

At/Near Boring	Approximate Water Line Invert Depth, ft.	Depth of Silty Sand Stratum	
		From	To
B-1	12	2	8**
		12***	16
B-10	12	14	16*****
B-33	11	12****	15.5*
B-21	8	10*****	13.5*
B-22	10	12*****	15.5*
B-8	12	14*****	16

* denotes bottom of boring
** denotes sands exist above the proposed flow line, and may be encountered during open cur and/or auger pit excavation
*** denotes sands exist right below the flow line; the possibility that sands may be encountered during water line installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors

****	denotes sands exist within one foot of the flow line; the possibility that sands may be encountered during water line installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors
*****	denotes sands exist within two foot of the flow line; the possibility that sands may be encountered during water line installation exists depending on mode/size of excavation and/or potential for variations in soil stratigraphy and other factors

The trench excavations can be made using cut slopes stepped back to stable slope, vertical cuts supported with sheet piles or other suitably designed retaining system. The excavation should be performed in accordance with the current OSHA 29 CFR Part 1926 of OSHA (Trench Safety System) and City of Houston Standard Specification, Section 02317 – Excavation and Backfill for Utilities.

Trenches should be provided with a proper trench support system. For the trench supporting system, the lateral pressures exerted on trench walls by stiff clays and cohesionless soils are presented in Figure 5a. Where soft to firm cohesive soils are encountered, the lateral pressure may be computed as given in Figure 5b. Where cohesive soils are underlain by sandy soils, the lateral pressure may be computed as given in Figure 5c. Temporary earth retaining walls are sometimes designed assuming an equivalent fluid pressure, in such cases, a lateral earth pressure equivalent imposed by a 84 PCF and 102 PCF fluid is recommended for clay soils above and below the water table, respectively; in sandy soils, a lateral earth pressure equivalent imposed by a 48 PCF and 85 PCF fluid is recommended for soils above and below the water table, respectively. Timber shoring as outlined in 29 CFR Part 1926 of OSHA recommendation may be used in the construction of trench supporting system. Trench boxes are commonly used for trench safety without shoring or bracing in open-cut excavations with vertical walls. In all cases, excavations should conform to OSHA guidelines.

<u>Vehicular and Other Surcharge Loadings</u>: Under normal loading conditions, a surcharge magnitude of q psf can result in lateral earth pressure of about 0.5q in cohesive soils and about 0.4q in sandy soils. All surcharge loads to a distance of 0.5 times the wall height should be considered. Due to the likely presence of roadways along the proposed pipeline alignment, the effects of vehicular traffic should be considered while designing the lateral supporting systems. The highway loading imposed by a H20 truck on a pipe under various depths of soil cover is presented in Figure 6. Figure 7

presents Boussinesq's equation for computing both horizontal and vertical stresses imposed by a surface surcharge load.

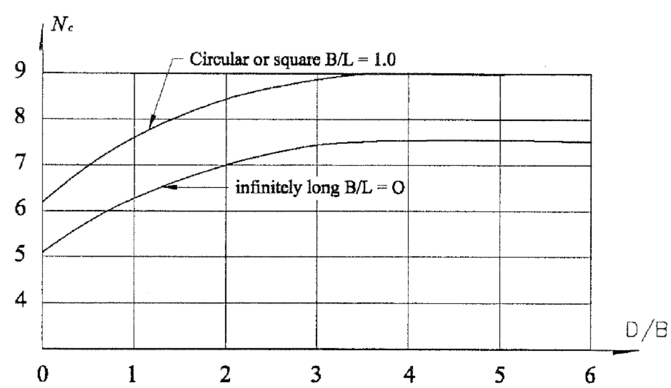
Stockpiling of excavated material should not be allowed near the excavation. Generally, a distance of at least one-half the excavation depth on both sides of the trench should be kept clear of any excavated material and height of stockpile should be limited to no more than 3 feet. If this is not possible due to space limitations then the retaining system design should be designed to take into account the surcharge loads.

In stable cohesive soils and where groundwater is lowered at least 3 feet below the excavation bottom, and if the sheeting terminates at the base of cut, the trench bottom stability can be evaluated in the following manner:

$$\text{Factor of safety } (F_s) = \frac{(N_c)\, C}{(\Upsilon)\, D + q}$$

Where,

N_c = Bearing capacity factor that depends on dimensions of the excavation:



N_c rectangular = $(0.84 + 0.16B/L)N_c$ square

C = Average undrained shear strength of clay in failure zone beneath and surrounding base of cut, psf.

ϒ' = Average effective unit weight of soils above trench bottom, pcf.

q = Surface surcharge, psf.

D = Depth of trench, ft.

L = Length of trench, ft.

B = Width of trench, ft.

If the factor of safety is less than 1.5, sheeting should be extended below the base of the cut to insure stability. The extended sheeting depth should be at least 1.5 times the trench width.

5.3 Groundwater Control

Groundwater information gathered from the soil borings during and at completion of drilling, as well as the 24-hour and 7 day water level readings in the piezometers were presented in Section 4.4. It should also be noted that groundwater levels will fluctuate as a result of seasonal rainfall variations.

The approximate flow line depths and the subsurface conditions as found in the soil borings are shown in the Boring Log Profiles on Figures 4a through 4n. Based on the proposed invert elevation and the groundwater information gathered during our field investigation, the water line construction excavations will not likely to encounter groundwater. It should be noted that groundwater level will fluctuate with the amount of precipitation and the prevailing environmental conditions prior to and during construction.

Seepage rate in clay soils, if exists, will likely be low, but seepage rate in sands (if exists) will be higher. Groundwater control for excavation in cohesive soils up to a depth of 15 feet, if required, can usually be accomplished by sump and pump arrangements because the seepage is relatively slow. For dewatering below the depth of about fifteen (15) feet multi-staged pumps will be required. When excavations extend into water-bearing sands/silts (not found in soil borings drilled in this investigation, but may be present away from the borings drilled or after heavy rainfalls), then dewatering using well points will be necessary. Criteria and requirements of City of Houston

Standard Specification, Section 01578 – Control of Ground Water and Surface Water should be followed.

Seams and pockets of sand, silt, ferrous nodules, and calcareous nodules that may exist in cohesive soil layers may form communicative drainage paths for the groundwater, leading to potential water-bearing/perched water condition, and as a result, accelerated the rate of seepage. If such unexpected phenomenon is observed during the trench excavation and construction, appropriate measures, such as proper dewatering and shoring methods, may have to be implemented under supervision of a Professional Civil/Geotechnical Engineer.

5.4 __Bedding Criteria__

Where water line is installed using open cut method, the trench bottom for water line placement should be over-excavated to a minimum of 12 inches. For auger pits the over excavation should be to a minimum of 6 inches. The space should be filled with bank sand to a depth of at least 12-inches above the pipe top and compacted to a minimum of 95 percent of the Standard Proctor (ASTM D 698) maximum dry density at a moisture content between -3 to +5 percent of the optimum moisture content. The trench bottom should be shaped to receive the water pipe. The bedding details should be in accordance with the latest City of Houston Construction Details. City of Houston Drawing No. 02317-04 should be used for the water main bedding and backfill. The bedding and backfill for auger pit should be in accordance with City of Houston Drawing No. 02447-01.

Soft and/or wet soils, if encountered at trench bottom, should be handled according to requirements specified in City of Houston Standard Specifications Section 02317, Subsection 3.07, A and B.

5.5 __Trench Backfill__

The backfill should conform to standard City of Houston Specification, Section 02317 – Excavation and Backfill for Utilities. The backfill materials should conform to standard City of Houston Specification, Section 02320 – Utility Backfill Materials.

The embedment material between the pipe and the trench (bedding, haunching and initial backfill) may consist of bank run sand placed in maximum six-inches compacted lift thickness and compacted to a minimum of 95 percent of the maximum dry density as determined by Standard Proctor test (ASTM D698) at –3 to +5 percent of the optimum moisture content.

In the trench zone within the pavement area, the backfill may consist of bank run sand or select fill. The bank run sand should be placed in maximum 12 inches loose lift thickness and compacted by vibratory equipment to a minimum of 95 percent of the maximum dry density at moisture content within zero percent to -3 and +5 percent of optimum as determined by ASTM D698. The select fill may be placed in maximum 6-inch compacted lift thickness and compacted to a minimum of 95 percent of the maximum dry density at moisture contents within 0 and +5 percent of optimum as determined according to ASTM D 698. The cut pavement should be replaced to match the existing pavement type and the thickness should be equal or greater then the existing pavement thickness. The finished pavement surface must be even with existing pavement elevation. In the trench zone outside the pavement area, a random backfill of suitable material (clayey soils) may be used. The random backfill may be placed in maximum 12 inches loose lift thickness for clayey soils and compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D 698 at moisture content necessary to achieve the density.

5.6 Loads on Buried Conduits

The pipelines placed at depths under the ground will be subject to loads due to backfill (earth loads) and loads due to vehicular traffic (live loads).

Earth Load: The earth loads on a buried pipe can be calculated based on Marston’s formulae (Ref: 1

through 3). The Marston's equation for buried conduits are generally given as:

$$W_d = C_d \Upsilon B_d^2 \qquad \text{- for rigid pipes}$$

$$W_d = C_d \Upsilon B_d B_c \qquad \text{- for flexible pipes}$$

Where, W_d = fill load, in pounds per linear foot of pipe

C_d = Marston's soil coefficient

Υ = Unit weight of fill material, pcf (use 120 pcf)

B_d = Width of trench at or slightly below top of pipe, in feet

B_c = Width of pipe, in feet

The above equation is valid when the conduit is placed in a trench not wider than 2.0 to 3.0 times its outside width. Marston's soil coefficient C_d can be obtained from Table 4. K is the active earth pressure coefficient and μ is the coefficient of sliding friction between the fill material and the sides of the trench. The height of fill and the horizontal width of trench should be considered from the top of the conduit. For the above equation for flexible pipes, an assumption of equal stiffness of soil and pipe has been used for its development and the equation generally gives a minimum load value. Hence, for flexible pipes including ones installed using trenchless construction, the earth loads may be conservatively calculated using the prism load theory. The prism load (Ref: 1 through 3) determines the weight of the soil column directly above the pipe and neglecting factors such as side wall friction and/or the cohesion of the soils. The prism load (in psf) may be calculated by multiplying the total unit weight of soil above the pipe (say 120 pcf) by the height, H (ft) of the soil fill. The prism load generally gives higher loading on the pipe and simulates the long term load imposed on the pipe.

Vehicular Load: For calculation of live loads, the width of the loaded area should be taken as the outside horizontal width of the pipe. Loading due to H20 vehicle should be considered for vehicular traffic. The estimated highway loading on a buried conduit imposed by a H20 truck, under various soil cover, is presented on Figure 6.

Surcharge Load: The stresses imposed by a surcharge load can be estimated using Boussinesq's Equation presented on Figure 7.

5.7 Trenchless Construction

The proposed water lines will be installed using trenchless technique. In general, trenchless installation may involve dry auger or slurry auger method. In the dry auger method, the casing is advanced by jacking while soils are excavated at the advancing end of the casing. In the slurry auger method, a small diameter pilot hole is first drilled between the access shafts, followed by reaming the pilot hole to full diameter by augering with slurry and installing casing or pipe by pull-back or jacking techniques. Requirements of City of Houston Standard Specification, Section 02447 – Augering Pipe and Conduit, should be followed.

The water line will be installed mostly in stiff to very stiff clays (with local soft to firm stratum), in which case the excavation face are anticipated to be stable. However, granular soils or soils with limited cohesion will likely be present at (but not limited to) locations identified in Table C of Section 5.2. Groundwater conditions observed in open boreholes during the field investigation and in piezometers are presented in Section 4.4.

Excavation face in granular soils (sand/silt/gravel), clay soils with slight/low plasticity or containing a significant amount of sands, and other caving soils, if encountered at/near the excavation face, will likely experience some degree of instability if the excavation face is unsupported, especially when these soils are saturated and/or subject to seepage pressure. In such cases, the following mitigating measures can be employed to improve the excavation stability:

1) Lower the groundwater table to at least 3 feet below the excavation bottom, and use colloidal drilling fluid (usually bentonite slurry) under controlled pressure to improve stability of the

excavation.

2) In conditions where mitigation measures employed in Item 1 above cannot adequately provide the excavation stability, a casing can be installed at the same time of the slurry augering to provide stability of the excavation and reduce settlement at the surface.
3) In ground conditions where highly unstable soils and/or high inflow rate/pressure exist, microtunneling machine equipped with face shield and pressure-balancing colloidal drilling fluid may be used to maintain the stability of the excavation face.
4) Alternatively, open cut with shoring or other methods approved by City of Houston Department of Public Works and Engineering, along with groundwater control, and other stabilizing techniques such as chemical grouting, may be used at locations with difficult subsurface conditions or site constraints.

It is the responsibility of the Contractor to select a trenchless technique for the installation of the proposed water line by taking into account the soil types and stratigraphy and the groundwater conditions as found in the soil borings; the Contractor should have a work crew with experience in working with the selected trenchless construction technique in subsurface conditions similar to those found along the project alignments. If necessary, the Contractor may conduct additional geotechnical investigation to provide more detailed subsurface conditions.

Auger pit construction criteria provided in City of Houston Standard Specification, Section 02447 – Augering Pipe and Conduit, should be followed. Shoring systems for the auger pits may be designed based on the lateral earth pressures and other considerations discussed in Section 5.2.

5.8 Effects of Trenchless Construction on Surrounding Structures

A properly designed and controlled augering/trenchless construction operation can reduce immediate soil movement and subsidence to a tolerable level. Nevertheless, some ground loss should be expected during any augering/trenchless construction operations. With good construction techniques, ground loss can be mitigated to acceptable levels. Augering/trenchless construction below pavement and buried utilities may lead to some future settlement due to loosening of the subgrade or bedding condition. Large ground loss can result from uncontrolled flowing ground. Such conditions may occur if water-bearing sands or silts were encountered (not encountered in our soil borings, but may be present away from the borings drilled) in the excavations along the augering/trenchless construction alignment. Measures to mitigate ground loss and other impacts of trenchless construction were addressed in Section 5.7.

The zone of influence of the augering/tunnel roughly extends to a distance equal to the invert depth on each side of the centerline of the augering/trenchless construction alignment. The amounts of settlement due to augering/trenchless construction are difficult to estimate. We anticipate that if good construction practices and control are exercised, the amount of ground settlements should be small. Establishing monitoring points on existing roadways, buildings and other important structures along the augering/trenchless construction alignments, and record coordinates and elevations prior to, during and after construction to monitor the amount of settlements or lateral movements due to augering/trenchless construction, and adjust augering/trenchless construction technique accordingly to mitigate the movements as necessary. Existing damages to the surrounding structures should be documented prior to starting of the augering/trenchless construction operations.

5.9 Thrust Restraint

Unbalanced thrust forces result from changes in flow directions and/or velocity in a pressurized pipe system (see Figure 8). The unbalanced thrust force and magnitude of thrust block force T is defined as follows:

$$T = 2\ PA\ \mathrm{Sin}\ (\theta/2)$$

Where, P = internal fluid pressure (psi);

A = cross-sectional area of pipe (in^2);

θ	= deflection angle of bend; and,
T	= thrust force (pounds)

Adequate restraint may be achieved by using thrust blocks, restraint joints, tie rods, or a combination of these systems. The unbalanced force acting on a pipe system is transmitted by a thrust block and resisted by the bearing area between the pipe and the foundation soils. The unbalanced force acting on a pipe system with restraint joints are resisted by the frictional forces between the pipe/soil interface across the pipe sections restrained to act integrally.

<u>Thrust Blocks</u>: Thrust blocks are commonly used to increase the bearing area to allow the fittings to resist movement. The procedures for thrust block design are given in detail in AWWA M9 (Ref. 1). The required thrust block bearing area is calculated based on the bearing capacity of the soil:

Required Bearing Area of Thrust Block = T/F

Where,	T	=	thrust force (lb); and,
	F	=	safe bearing value for soil (lb/sq.ft)

A safe bearing value of 1,500 psf can be used for thrust block design bearing on compacted soils. This value includes a factor of safety of 3. The blocks must be placed against undisturbed or compacted soils and the face of the block must be perpendicular to the direction of and centered on the line of action of the thrust. Proper care must be exercised after construction to prevent failure due to any future excavations behind the blocks.

<u>Restrained Joints</u>: Restrained joints are typically used to avoid the uncertainties of thrust blocking like future excavations, etc. A detailed procedure for designing restrained joints including example calculations is outlined in the AWWA design manual M9 (Ref. 1). The following soil parameters are recommended for the design of the restrained joint(s):

Average unit weight of soil, γ = 120 pcf

Cohesion of soils, C = 250/500/1000 psf (for soft/firm/stiff clays)

For coefficient of friction between pipe and granular soils, f, use 0.25 for smooth PVC and steel pipes, and use 0.3 for concrete pipes.

5.10 Flexible Pipe Deflection

The deflection of a flexible pipe may be determined using the modified Iowa formula of Watkins and Spangler (Ref. 2) as given below:

$$\Delta x = D_l \left[KWr^3 / (EI + 0.061 E' r^3) \right]$$

Here EI is the pipe wall stiffness (in-lb.), r is the radius (in.) and W is the load per unit of pipe length (lb/in. in. of pipe). Where prism loads (i.e. weight of soil above the pipe) are used for pipe earth loads, a deflection lag factor, D_l of 1.0 may be used. Otherwise, deflection lag factor, D_l of 1.5 should be used. The bedding constant, K, may be taken as 0.1. The following typical soil parameters are recommended:

Soil Type	Soil Consistency	Unit Weight, pcf	Shear Strength (c), psf or SPT Blow Counts, blows/ft	Modulus of Soil Reaction, psi/in
Fat Clays and Lean Clays	Soft	120	$c \leq 250$	100
	Firm	124	$c \leq 500$	300
	Stiff	128	$c \leq 1,000$	600
	Very Stiff	130	$c \leq 2,000$	1,000
	Hard	132	$c > 2,000$	2,000
Granular Soils: Sands, Silts and Gravel	Loose	110	$2 \leq N_{SPT} \leq 7$	300
	Loose to Medium Dense	113	$8 \leq N_{SPT} \leq 15$	600
	Medium Dense	115	$16 \leq N_{SPT} \leq 30$	1,000
	Dense	118	$N_{SPT} > 30$	2,000

* Buoyant soil unit weight is computed by subtracting unit weight of water from the soil unit weight

5.11 Buoyant Uplift

Portion of a buried structure located below the water table is subject to an upward hydrostatic pressure, called the *buoyant uplift pressure*. Resistance to buoyant uplift pressure is provided by the following components:

- *Weight of the structure (W)*
- *Weight of the soil above the base extension beyond the wall(Ws)*
- *Frictional force between the soil and foundation (Fs).*

Buoyant Uplift Resistance = W + Ws + Fs

W and Ws are can be readily computed. The computation of the buoyant uplift, and the skin friction resistance are shown in Figure 9. If base extension option is used, we recommend using a buoyant unit weight of backfill soil above the base extension of 65 pcf when computing Ws.

5.12 Street Cut and Repair

Any street cut necessary for this project should be restored to its original condition using material similar in nature and thickness to the existing streets. Recommendations outlined in City of Houston Standard Specification, Section 02951 – Pavement Repair and Resurfacing should be followed. The top 8 inches of the subgrade soils in the pavement repair areas should be stabilized. ATL recommends stabilizing subgrade clay soils with plasticity indices above 15 and above 25 with at least 6 and 7 percent lime, respectively, and stabilizing granular soils and clay soils with plasticity indices of less than 15 with at least 4 percent lime and 8 percent fly ash, on a weight basis; optimum amount of stabilization shall be determined by conducting laboratory testing.

The lime and lime-fly ash stabilization should be carried out in accordance with City of Houston Standard Specifications Section 02336 and 02337, respectively.

6.0 CONSTRUCTION CONSIDERATION

The proposed water line installation will involve mostly trenchless construction techniques and some open cut/trenching construction. Accordingly, the water line installation excavations will be installed mostly in stiff to very stiff clay soils with local areas of soft to firm stratum. However, granular soils or soils with limited cohesion will likely be present at (but not limited to) locations identified in Table C of Section 5.2.

Excavation face in granular soils (sand/silt/gravel), soils with only slight plasticity and other caving soils (if encountered), will likely experience some degree of instability if the excavation face is unsupported, especially when these soils are saturated and/or subject to seepage pressure. In such cases, mitigating measures as discussed in Section 5.7 of this report can be employed to improve the excavation stability.

Based on the proposed invert elevation and the groundwater information gathered during our field investigation, the proposed water line construction excavations will not likely to encounter groundwater. However, it should be noted that groundwater level will fluctuate with the amount of precipitation and the amount of precipitations prior to and during construction. For water line installation excavation advanced in clay soils, the seepage rates are usually low, and groundwater control can usually be controlled by sumping and pumping. However, for excavations advanced in water-bearing sands/silts stratum (not encountered in our soil borings, but may be present away from our soil borings and/or after heavy reainfalls), where water inflow rate is high, dewatering using well points will be required to provide a dry working platform and to prevent soil boiling.

It is the responsibility of the Contractor to select a trenchless technique for the installation of the proposed water line by taking into account the soil types and stratigraphy and the groundwater conditions as found in the soil borings; the Contractor should have a work crew experienced at working with the selected trenchless construction technique in subsurface conditions similar to those found in along the project alignments. If necessary, the Contractor may conduct additional geotechnical investigation to provide more detailed subsurface conditions.

6.1 Quality Control

Associated Testing Laboratories, Inc. (ATL) recommends implementation of a comprehensive quality control program under the supervision of a Professional Engineer due to the fact that a considerable amount of excavation and back filling may be required in the proposed project area. Structural integrity and stability is particularly dependent on quality foundation installation, bedding and subgrade preparations. An independent testing laboratory should be assigned to test and inspect construction materials during the construction phase.

To ensure that excavation will remain stable, to provide sufficient headroom for working, to provide worker's safety and to protect adjacent structures, the excavations will have to be provided with sufficient side slopes or shored in accordance with OSHA "Trench Safety Systems" (29 CFR Part 1926), as published in the Federal Register, Vol. 52, No.72, Section 1926-650 through 1926-653. Excavation of the trenches and access pits should be carried out under the supervision of an experienced construction supervisor and necessary shoring and/or bracing of the trenches should be properly installed. In temporary braced or shored excavations and in access pits where the sheeting terminates at the base of the trench, lateral earth pressure, surcharge, and seepage pressure caused by a differential hydrostatic head moving upward to the bottom of the trench can cause trench bottom instability. Therefore, it is recommended that, if the bottom stability evaluation yields a factor of safety less than 1.5, the sheeting should be extended below the base of cut. Before filling operations take place, representative samples of the proposed fill material should be tested by an independent laboratory to determine the compaction and classification characteristics.

6.2 Monitoring

Despite the thoroughness of this geotechnical exploration, there is always the possibility that actual subsurface conditions may differ from the predicted conditions because conditions between soil borings can be different from those at specific boring locations.

Any excessive ground movements like settlement and lateral movement should be monitored and controlled. This can be done by performing a preconstruction survey including photography and documentation of existing conditions like elevations, cracks, etc., and by installing ground movement monitoring devices such as inclinometers, crack monitors, and establishing elevation monitor stations along the waterline alignment to monitor the ground movement after commencement of the excavation.

Associated Testing Laboratory, Inc. (ATL) recommends a regular inspection and overall project monitoring by a geotechnical engineer during the construction phase. The purpose of inspection is to provide sound engineering and judgement alternatives during construction, if unanticipated conditions occur.

7.0 LIMITATIONS

The information, findings and recommendations contained in this report are based on data obtained from test borings at the locations shown in Figures 2a through 2c, a reasonable volume of laboratory tests, and professional interpretation and evaluation of the field and laboratory data, and consideration of the project information furnished. Should it become apparent during construction that soil conditions differ significantly from those discussed in this report, this office should be notified immediately so that further evaluation and any necessary adjustments can be made.

8.0 REFERENCES

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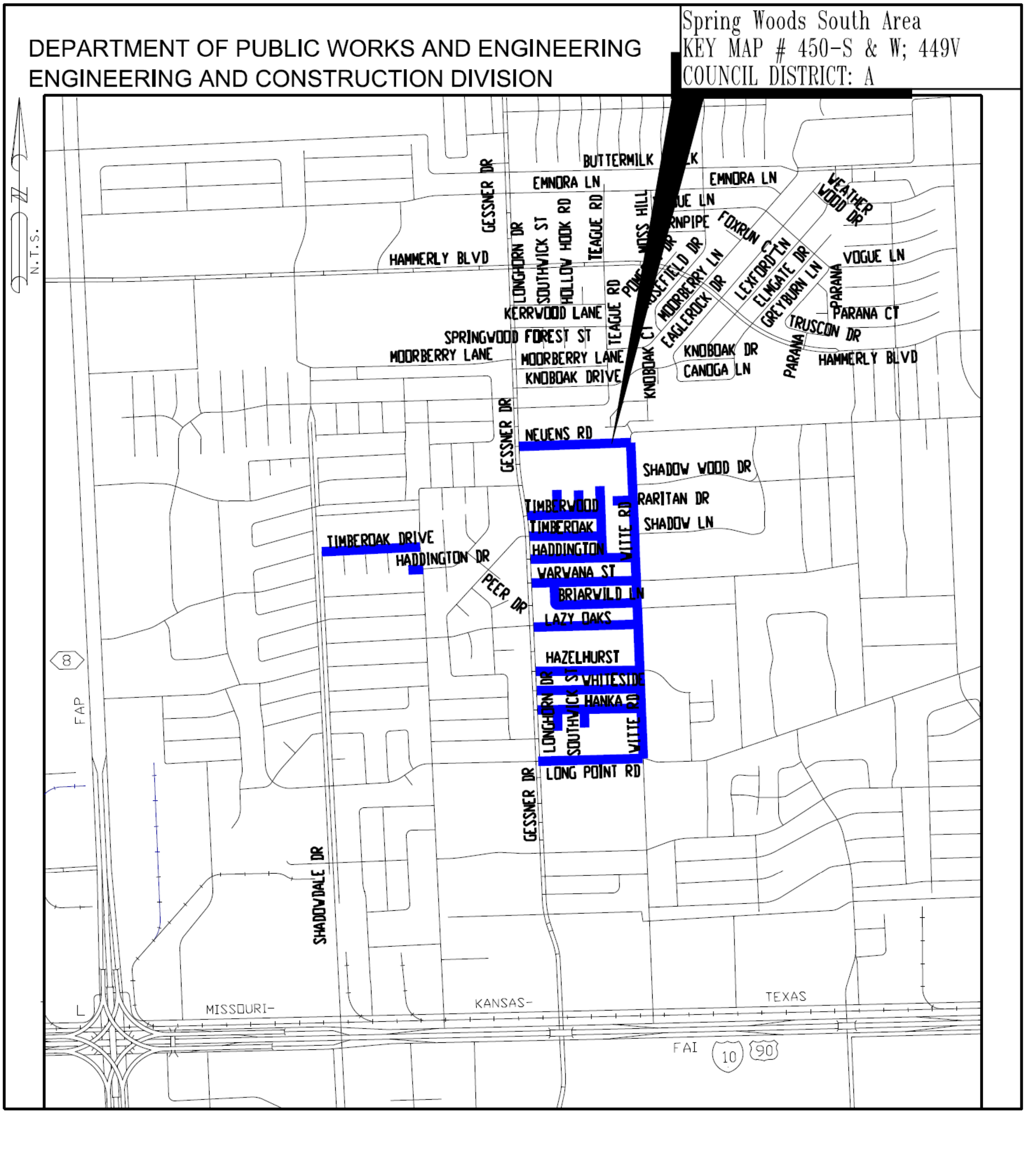
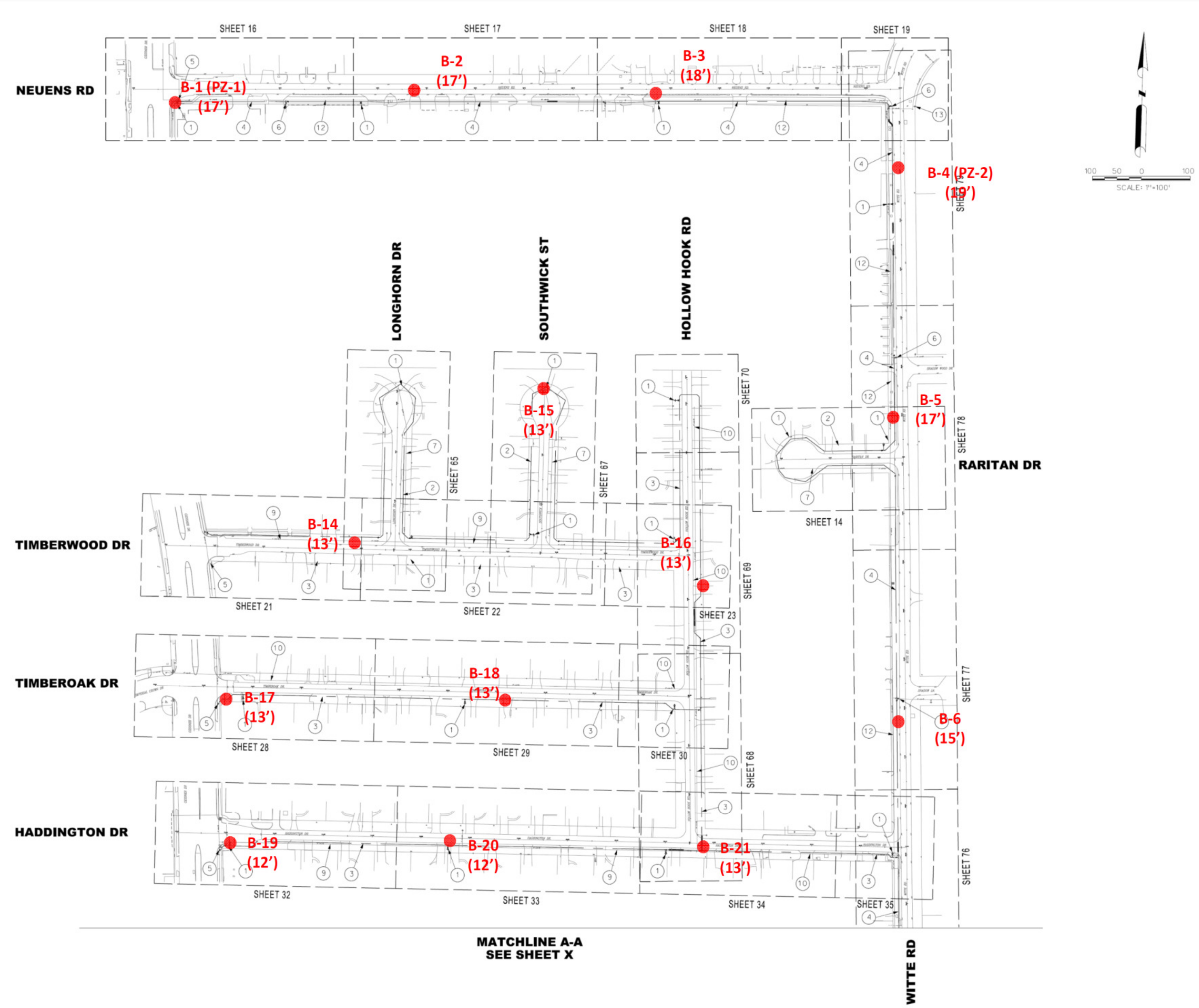
13. CFR PART 1926.

LIST OF FIGURES

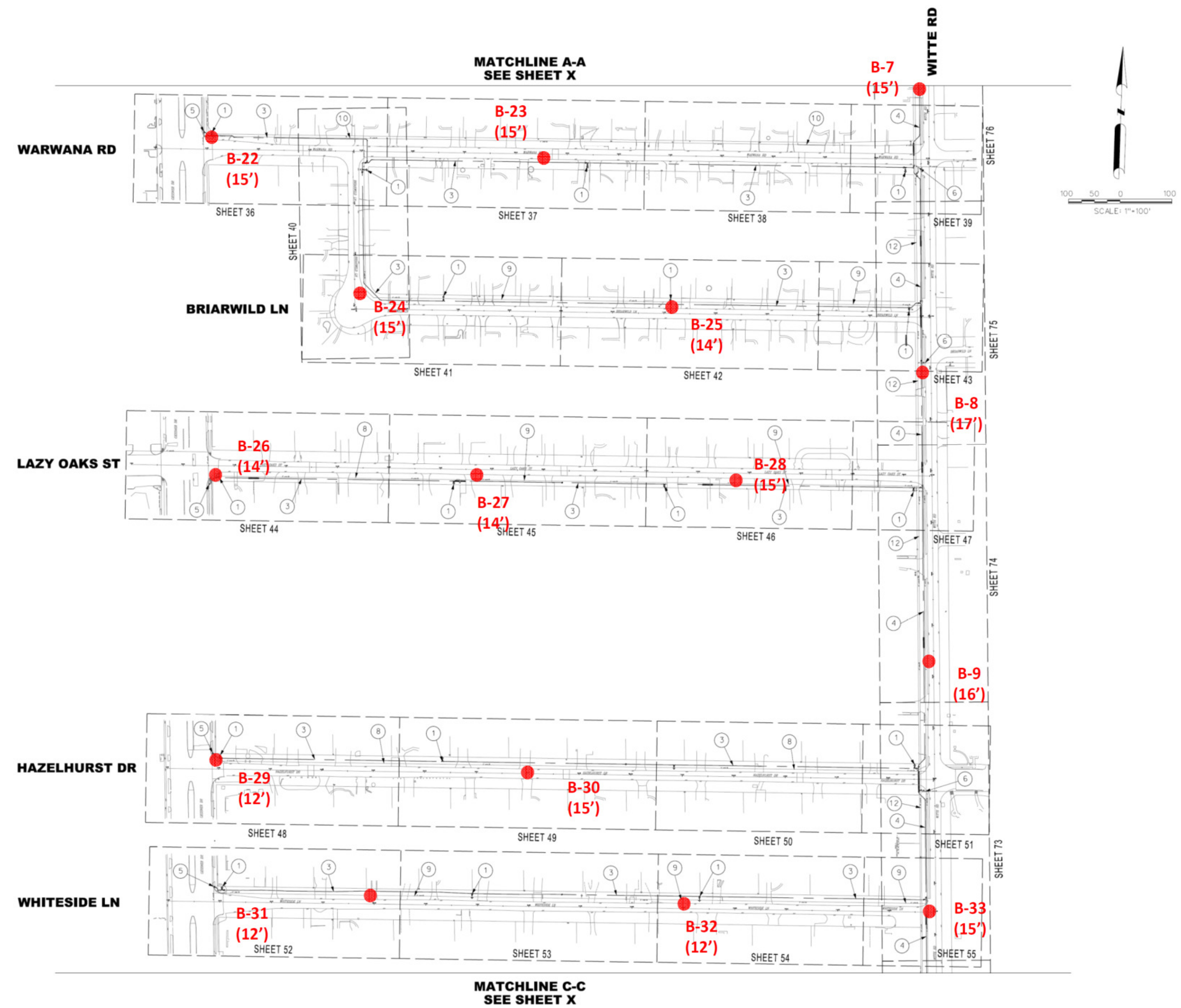


SITE VICINITY MAP	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-000035-0181-4 PROJECT NO. : G13-165 — FIGURE 1

PST 8/28/12



LOCATION OF BORINGS	ASSOICATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS No. S-00035-0181-4	
	PROJECT NO. : G13-165	FIGURE 2a



LOCATION OF BORINGS

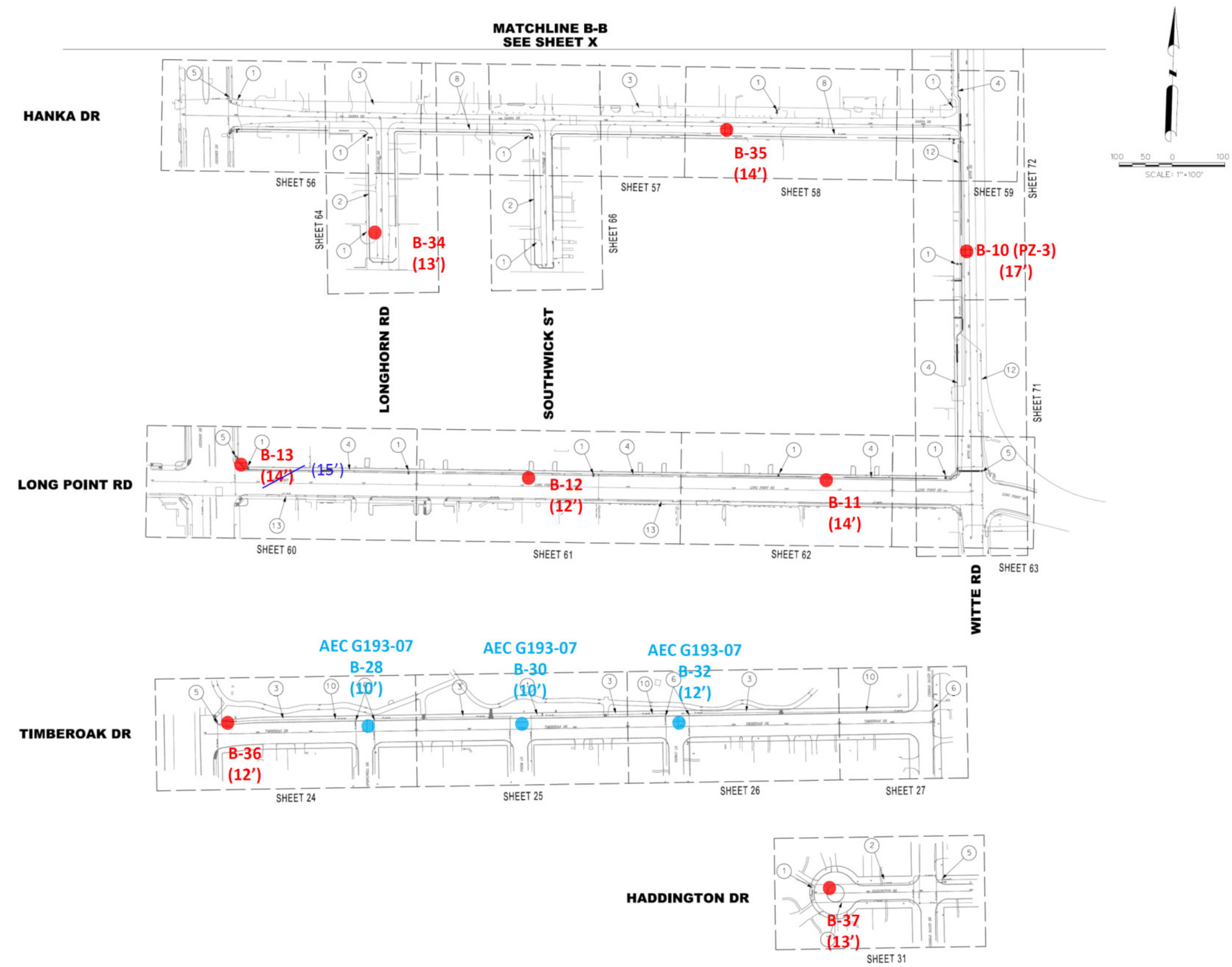
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA

ASSOICATED TESTING LABAORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS
TEL: (713) 748-3717 Fax: (713) 748-3748

WBS No. S-00035-0181-4

PROJECT NO. : G13-165

FIGURE 2b



LOCATION OF BORINGS

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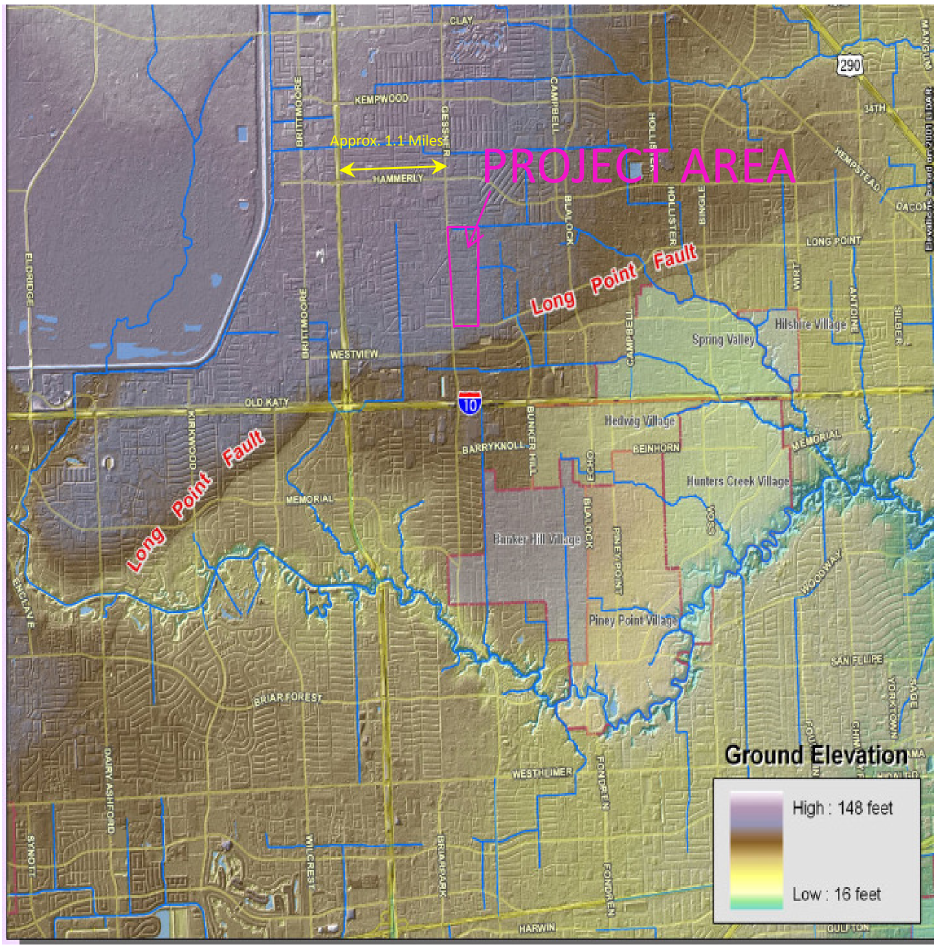
WBS No. S-00035-0181-4

PROJECT NO. : G13-165

FIGURE 2c



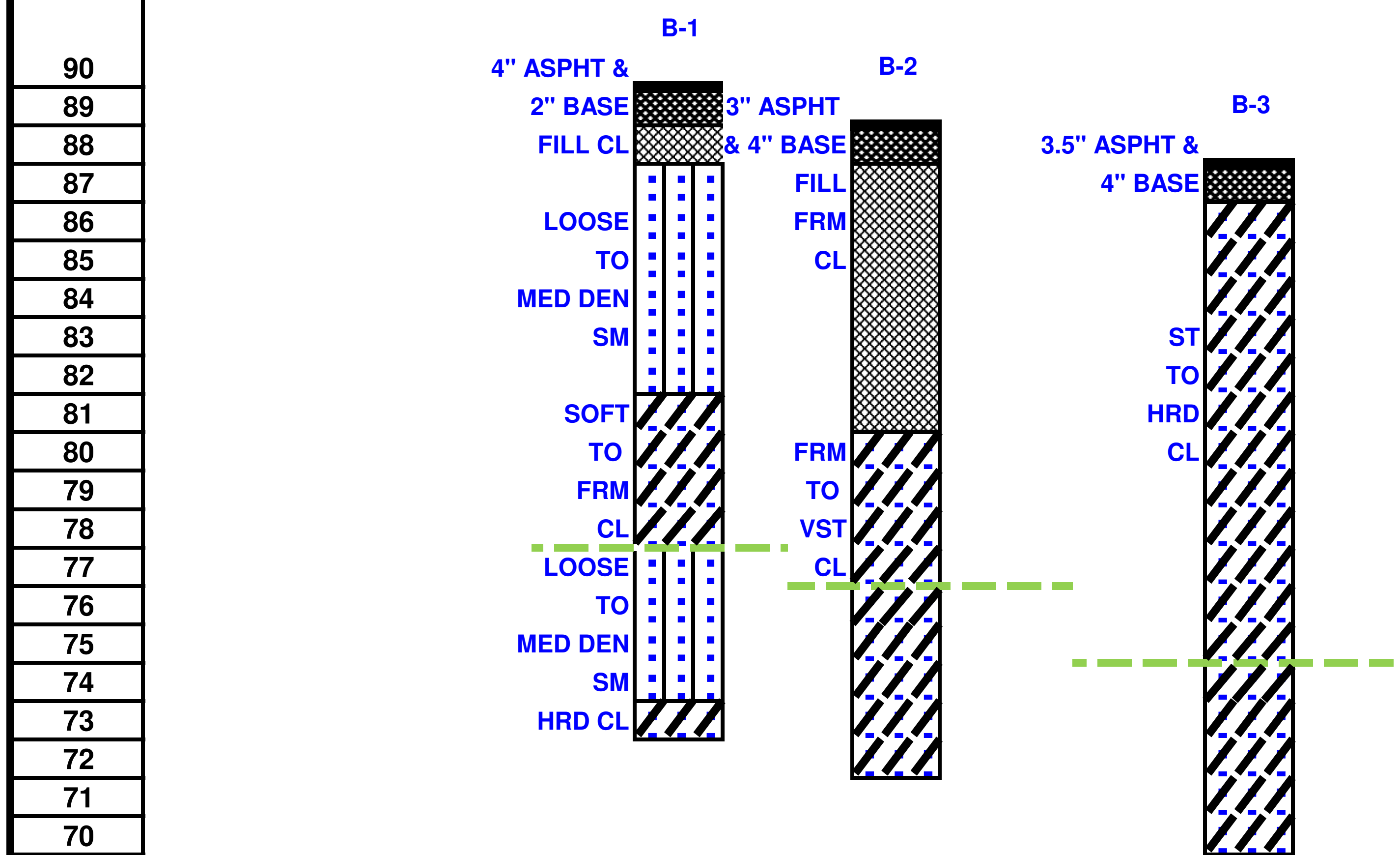
Source: USGS, in corporation with HGAC, 2004

LIDAR IMAGERY OF LONG POINT FAULT	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOOD S. AREA	WBS No. S-00035-0181-4 PROJECT NO. : G13-165 — FIGURE 3

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA — PROJECT NO. G13-165

Depth (ft.) — WBS No. S-000035-0181-4



PROFILE ALONG NEUENS ROAD

- Water First Noticed
- Depth To Water At Completion
- 24 hr. Water Level
- PZ Water Level (7-29-13)
- PZ Water Level (8-22-13)

KEY

CH- Fat Clay		ST - Stiff
CH- Fat Clay With Sand		VST - Very Stiff
CL- Lean Clay With sand		FRM - Firm
CL- Sandy Lean Clay		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

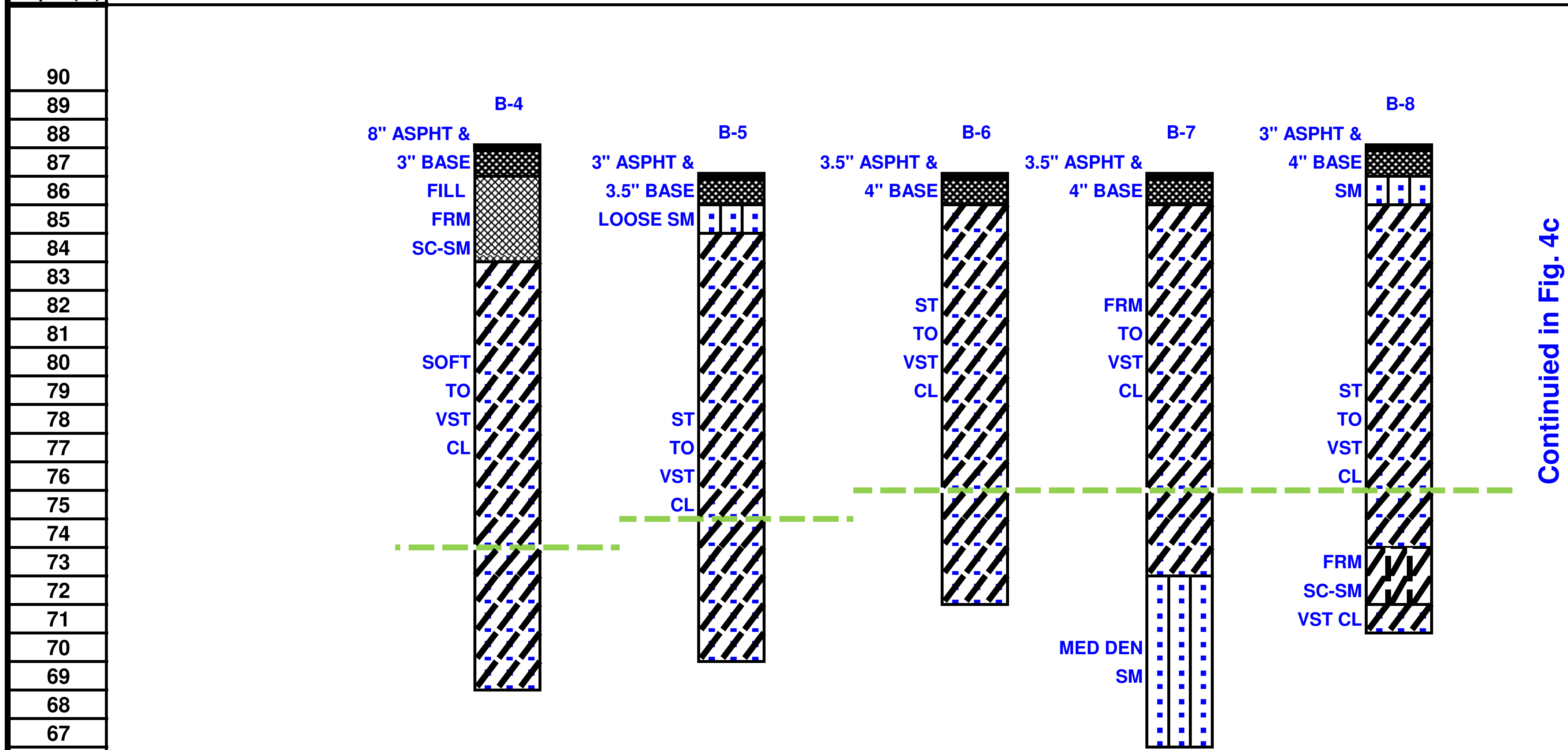
SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4a

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA — PROJECT NO. G13-165

WBS No. S-000035-0180-4



PROFILE ALONG PROFILE ALONG WITTE ROAD

KEY

CH- Fat Clay		ST - Stiff
CH- Fat Clay With Sand		VST - Very Stiff
CL- Lean Clay With sand		FRM - Firm
CL- Sandy Lean Clay		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

- ▽ Water First Noticed
- ▼ (orange) Depth To Water At Completion
- ▼ 24 hr. Water Level
- ▼ (red) PZ Water Level (7-29-13)
- ▼ (green) PZ Water Level (8-22-13)

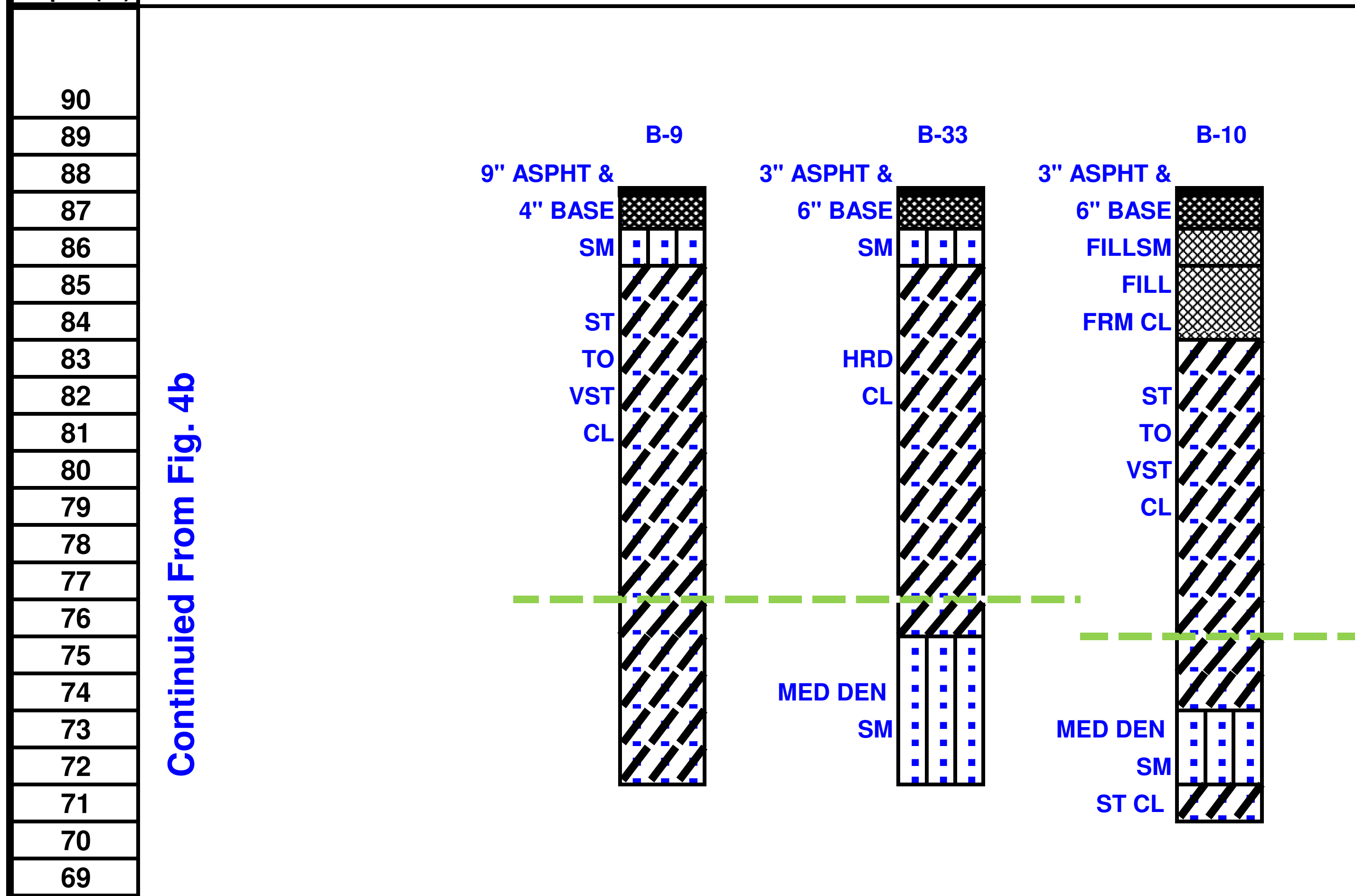
SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4b

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA — PROJECT NO. G13-165

Depth (ft.) — WBS No. S-000035-0180-4



PROFILE ALONG PROFILE ALONG WITTE ROAD

▽ Water First Noticed

▼ Depth To Water At Completion

▼ 24 hr. Water Level

▼ PZ Water Level (7-29-13)

▼ PZ Water Level (8-22-13)

KEY

CH- Fat Clay	ST - Stiff
CH- Fat Clay With Sand	VST - Very Stiff
CL- Lean Clay With sand	FRM - Firm
CL- Sandy Lean Clay	HRD - Hard
SM- Silty Sand	MED DEN - Medium Dense

SCALE

Horizontal: 1"= 500'

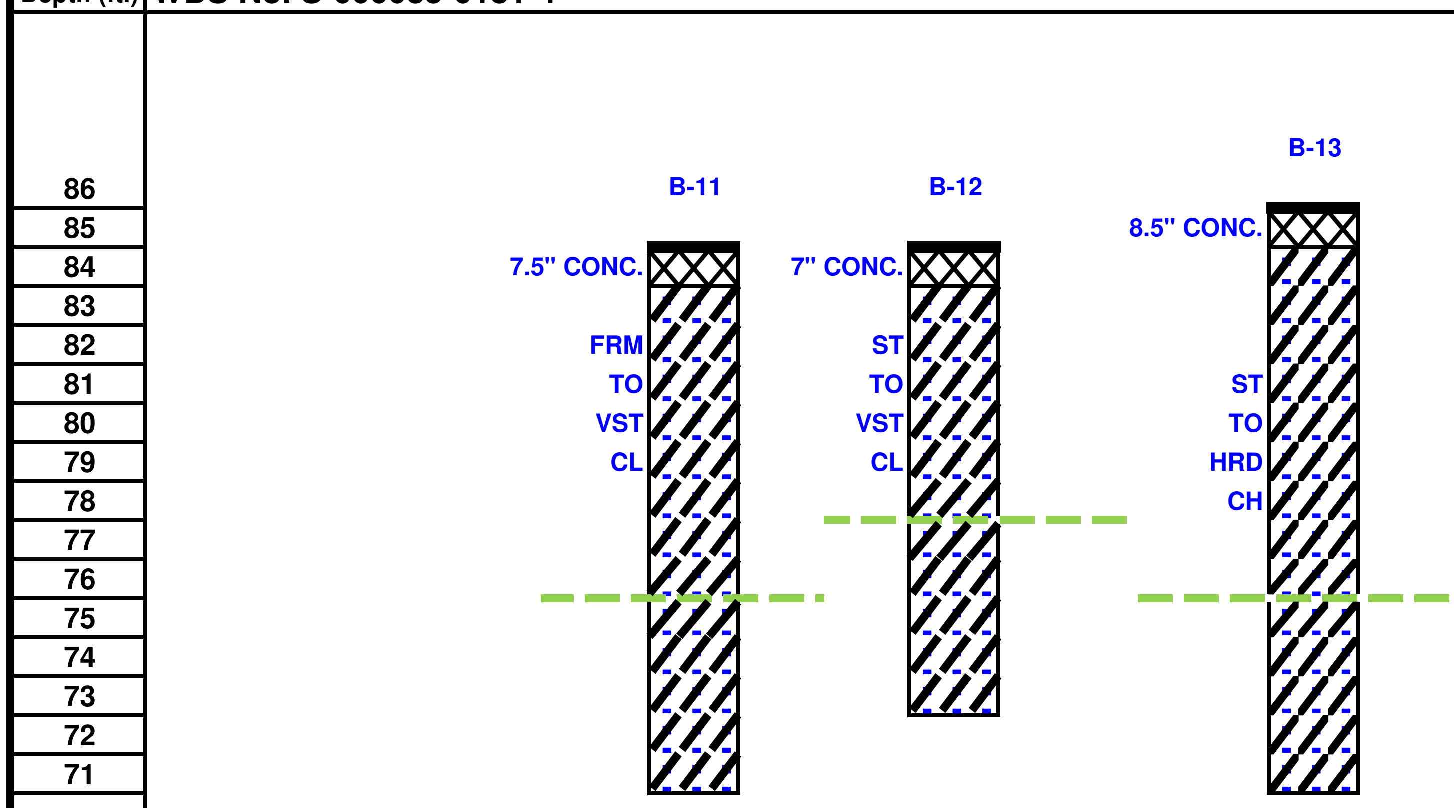
Vertical: 1"= 5'

Figure-4c

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA | PROJECT NO. G13-165

WBS No. S-000035-0181-4



PROFILE ALONG LONG POINT DRIVE

▽ Water First Noticed

▼ Depth To Water At Completion

KEY

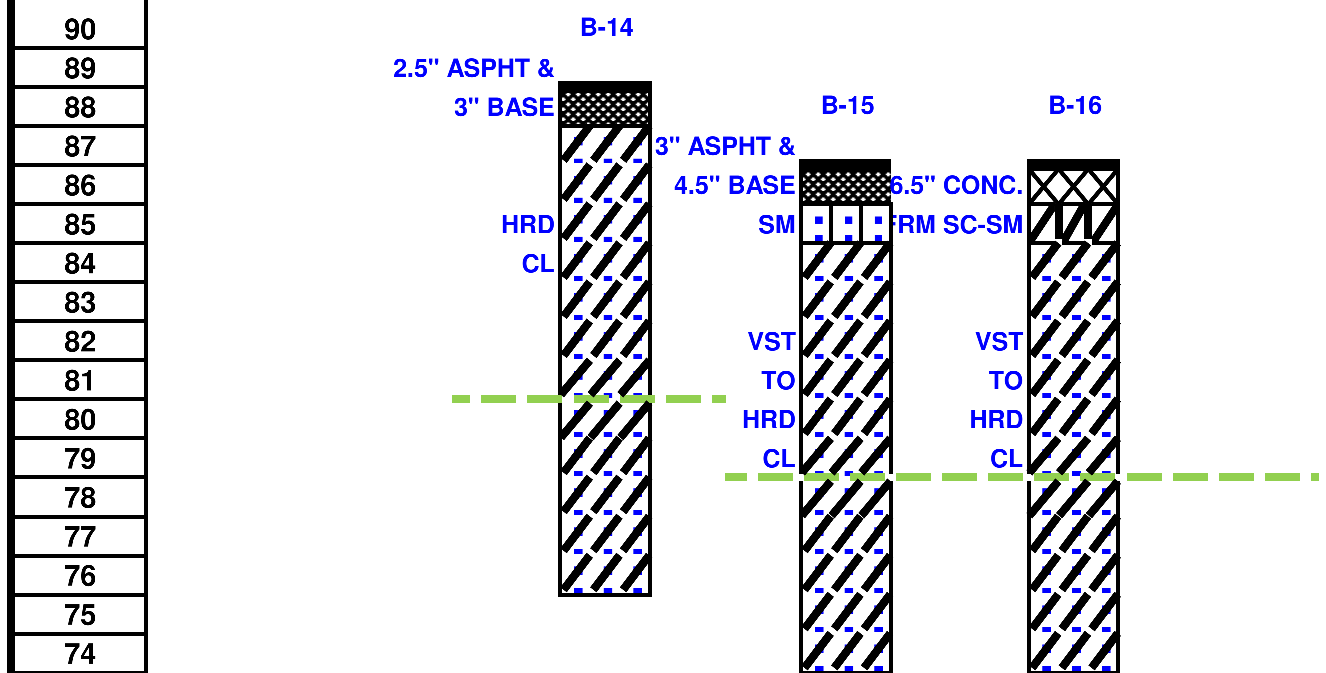
CH- Fat Clay	ST - Stiff
CH- Fat Clay With Sand	VST - Very Stiff
CL- Lean Clay With sand	FRM - Firm
CL- Sandy Lean Clay	HRD - Hard
SM- Silty Sand	MED DEN - Medium Dense

SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4d

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS

Depth (ft.) WBS No. S-000035-0181-4



PROFILE ALONG TIMBERWOOD DRIVE

Water First Noticed

Depth To Water At Completion

KEY

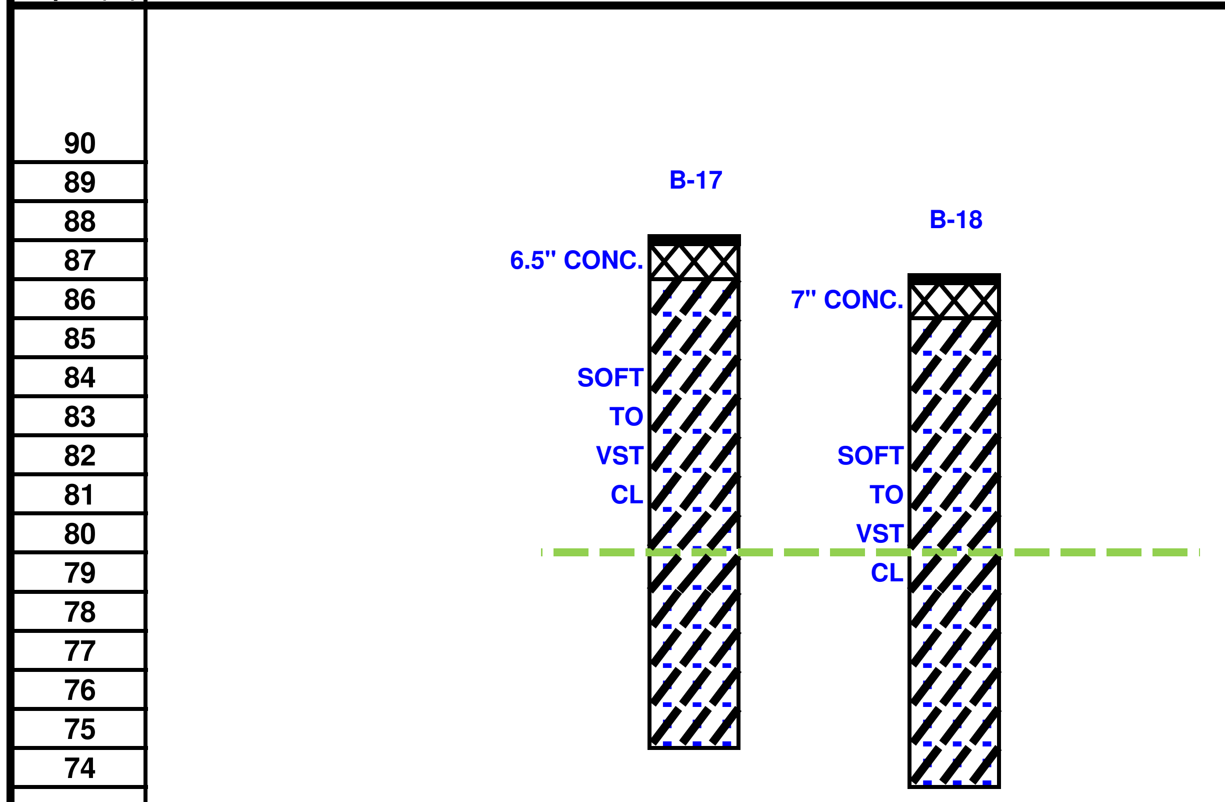
CH- Fat Clay		ST - Stiff
CH- Fat Clay With San		VST - Very Stiff
CL- Lean Clay With sa		FRM - Firm
CL- Sandy Lean Clay		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS — PROJECT NO. G13-165

WBS No. S-000035-0181-4



PROFILE ALONG TIMBEROAK DRIVE (E)

KEY

CH- Fat Clay		ST - Stiff
CH- Fat Clay With Sand		VST - Very Stiff
CL- Lean Clay With sand		FRM - Firm
CL- Sandy Lean Clay		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

▽ Water First Noticed

▼ Depth To Water At Completion

SCALE

Horizontal: 1"= 500'

Vertical: 1"= 5'

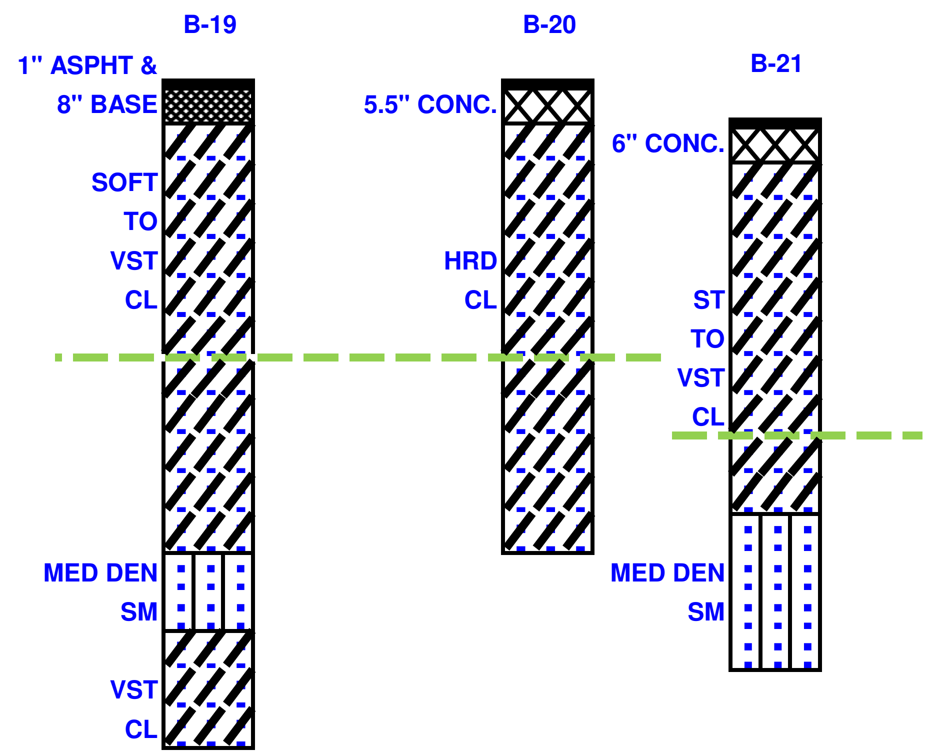
Figure-4f

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS | PROJECT NO. G13-165

Depth (ft.) | WBS No. S-000035-0181-4

Depth (ft.)
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71



PROFILE ALONG HADDINGTON DRIVE (E)

Water First Noticed

Depth To Water At Completion

KEY

CH- Fat Clay	ST - Stiff
CH- Fat Clay With Sa	VST - Very Stiff
CL- Lean Clay With s	FRM - Firm
CL- Sandy Lean Clay	HRD - Hard
SM- Silty Sand	MED DEN - Medium Dense

SCALE

Horizontal: 1"= 500'

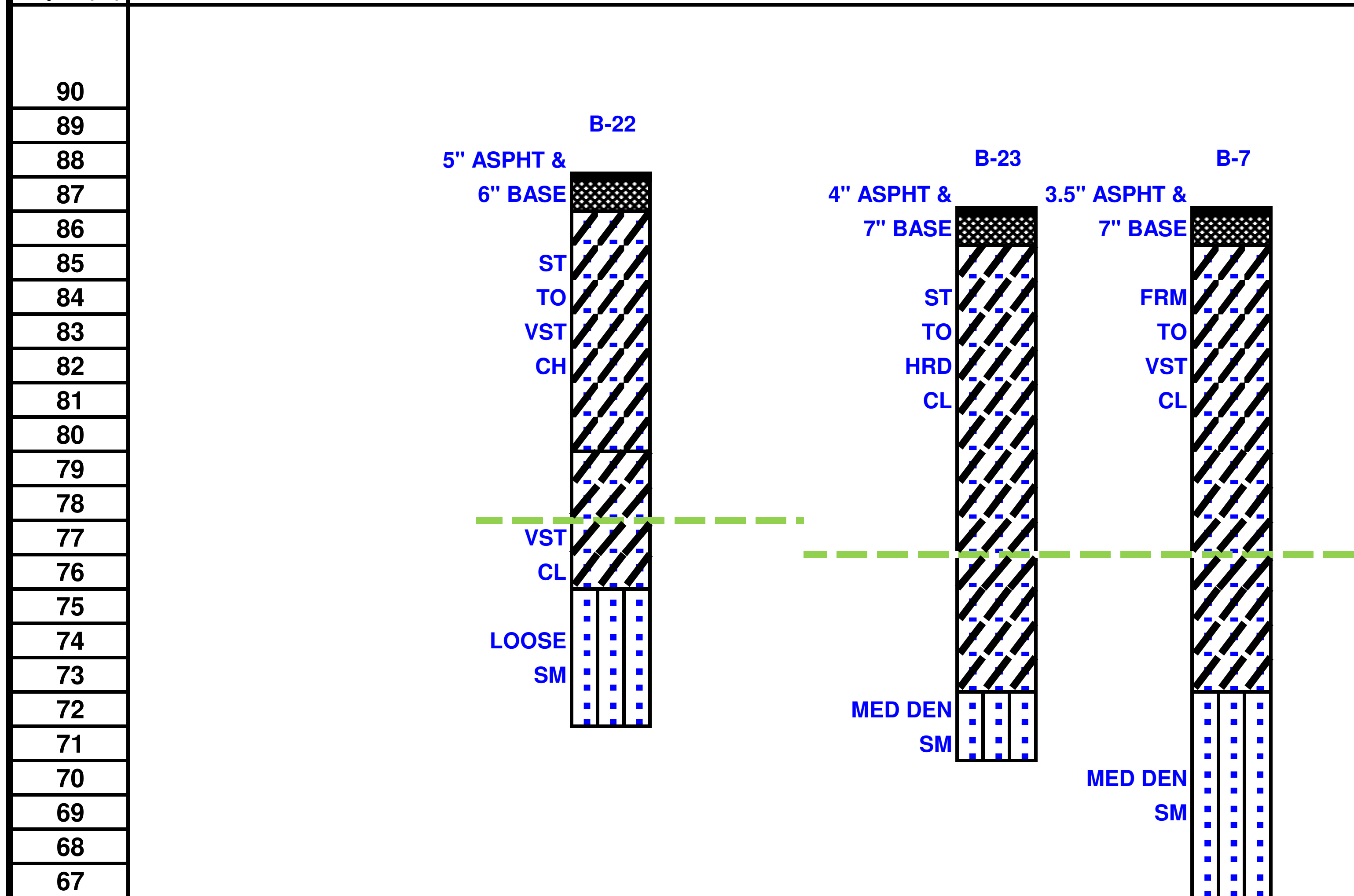
Vertical: 1"= 5'

Figure-4g

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS — PROJECT NO. G13-165

Depth (ft.) WBS No. S-000035-0181-4



PROFILE ALONG WARWANA ROAD

▽	Water First Noticed
▼	Depth To Water At Completion

KEY

CH- Fat Clay	ST - Stiff
CH- Fat Clay With Sand	VST - Very Stiff
CL- Lean Clay With san	FRM - Firm
CL- Sandy Lean Clay	HRD - Hard
SM- Silty Sand	MED DEN - Medium Dense

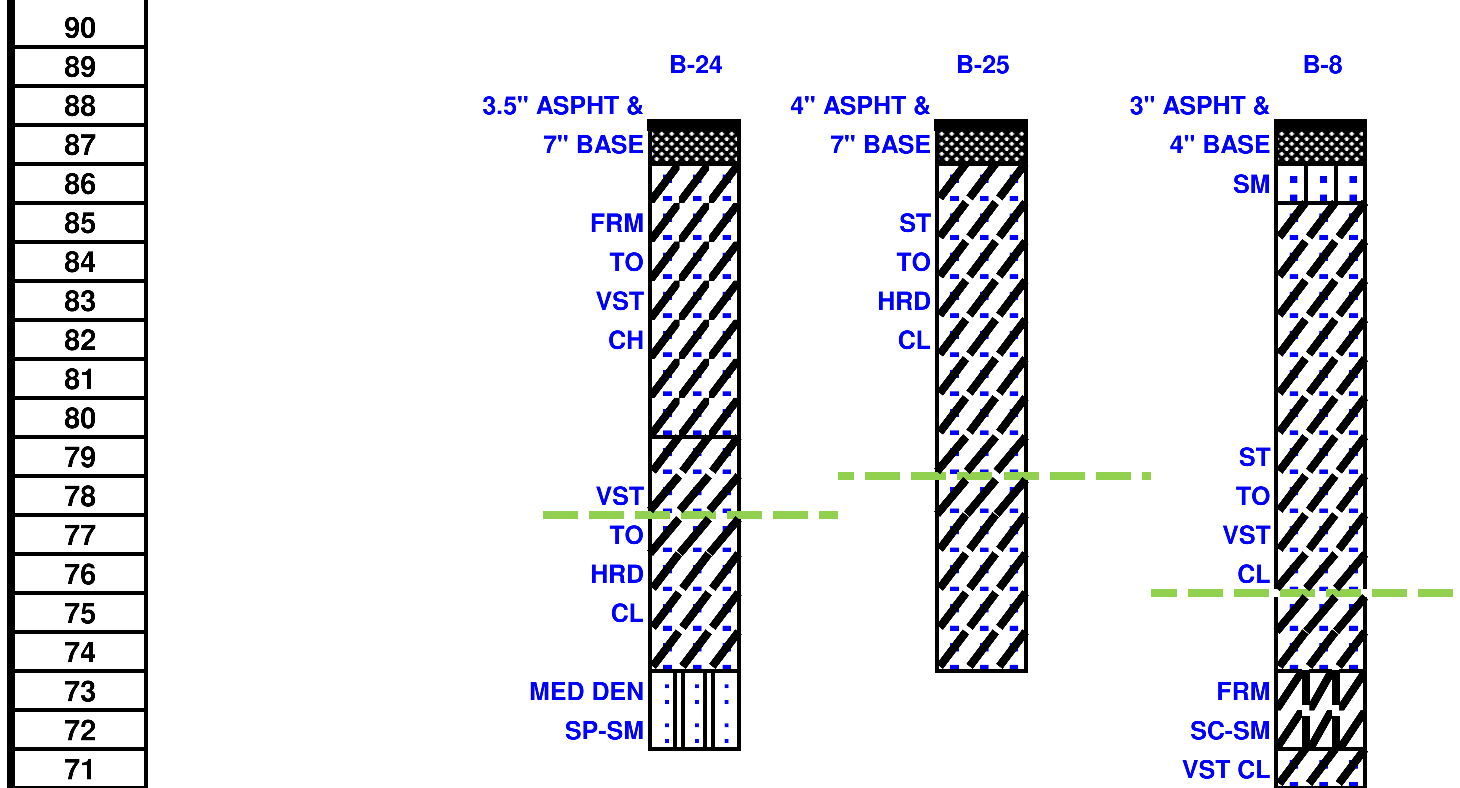
SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4h

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS — PROJECT NO. G13-165

Depth (ft.) — WBS No. S-000035-0181-4



PROFILE ALONG BRIARWILD LANE

▽	Water First Noticed
▼	Depth To Water At Completion

KEY

CH- Fat Clay		ST - Stiff
CH- Fat Clay With S		VST - Very Stiff
CL- Lean Clay With		FRM - Firm
CL- Sandy Lean Cla		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

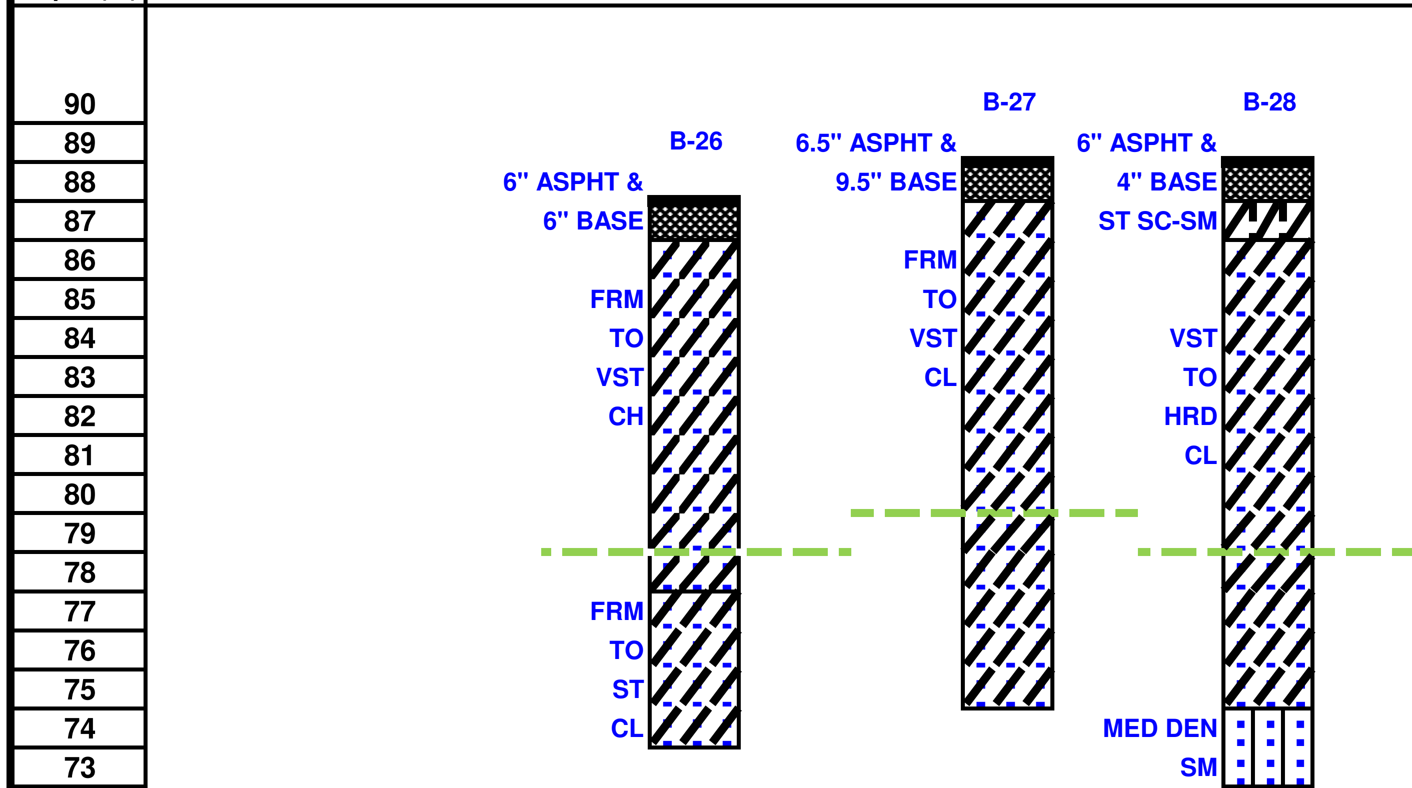
SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4i

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS — PROJECT NO. G13-165

Depth (ft.) WBS No. S-000035-0181-4



PROFILE ALONG LAZY OAKS STREET

▽	Water First Noticed
▼	Depth To Water At Completion

KEY

CH- Fat Clay		ST - Stiff
CH- Fat Clay With		VST - Very Stiff
CL- Lean Clay Wi		FRM - Firm
CL- Sandy Lean C		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

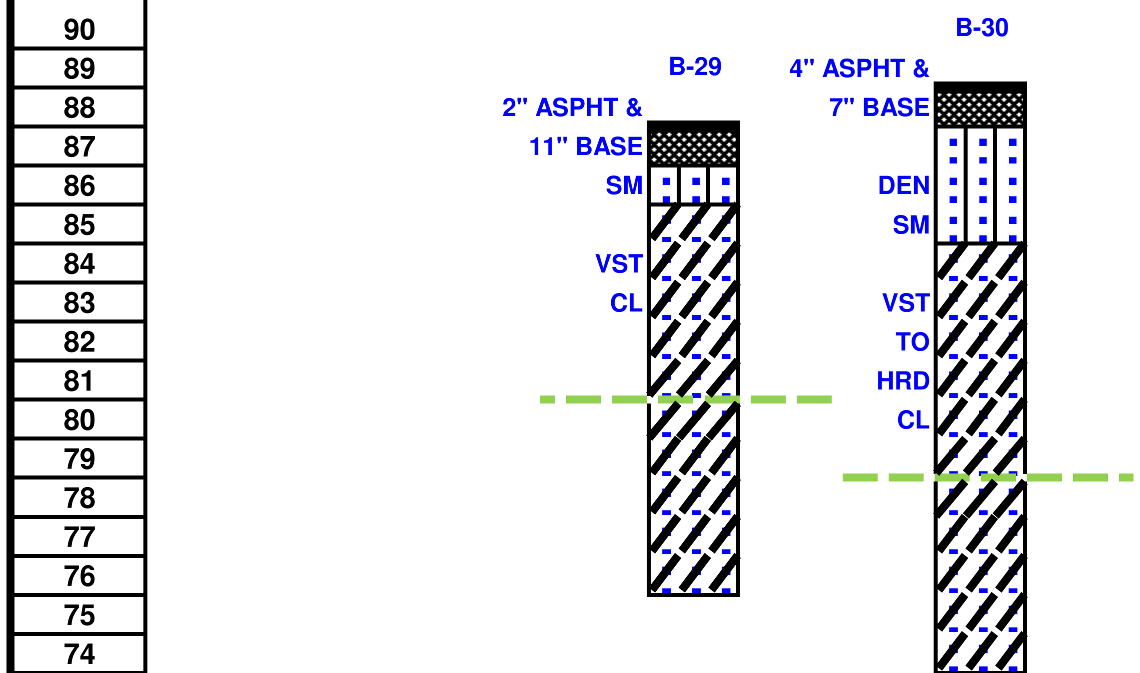
SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4j

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS — PROJECT NO. G13-165

Depth (ft.) — WBS No. S-000035-0181-4



PROFILE ALONG HAZELHURST DRIVE

▽ Water First Noticed

▼ Depth To Water At Completion

KEY

CH- Fat Clay	ST - Stiff
CH- Fat Clay With Sand	VST - Very Stiff
CL- Lean Clay With sand	FRM - Firm
CL- Sandy Lean Clay	HRD - Hard
SM- Silty Sand	MED DEN - Medium Dense

SCALE

Horizontal: 1"= 500'

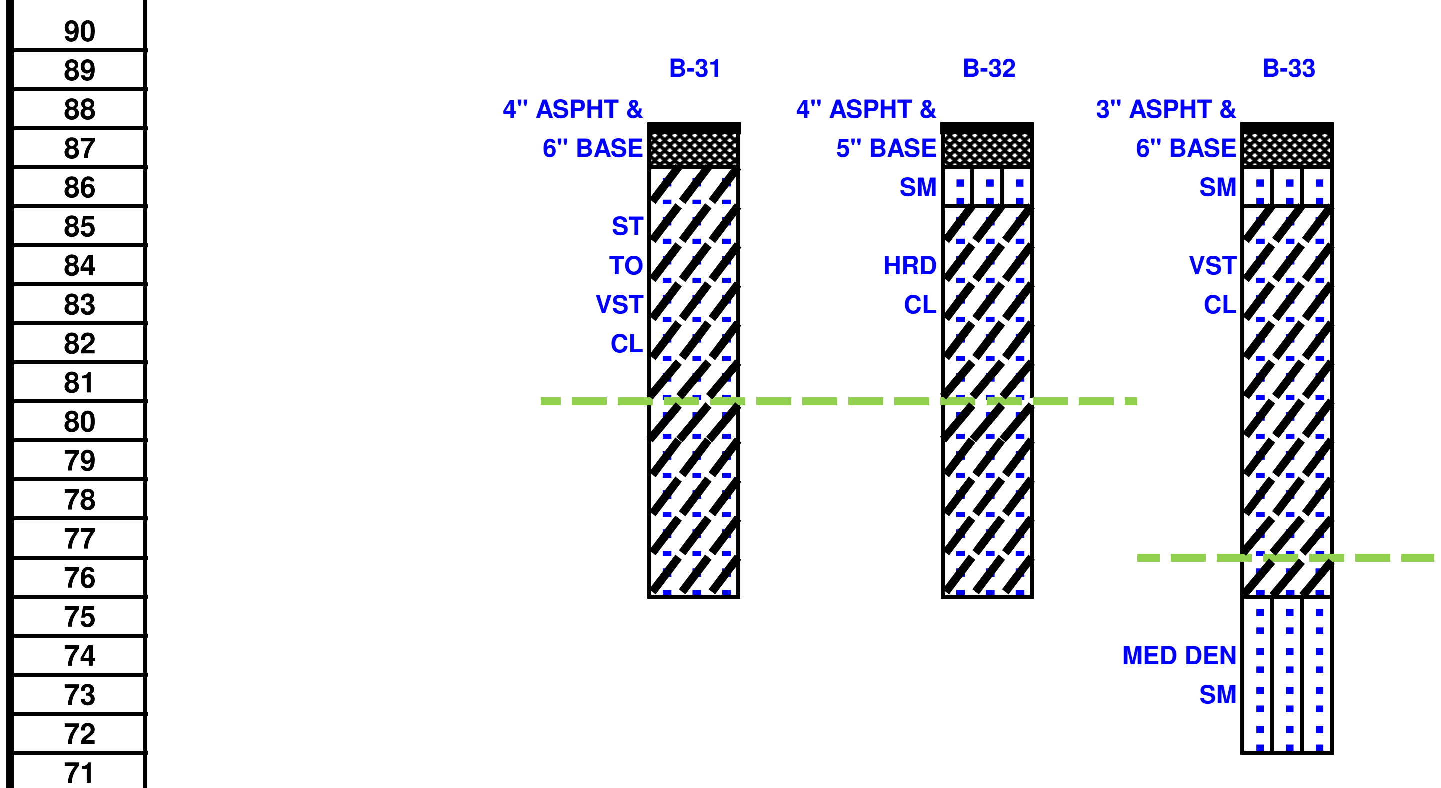
Vertical: 1"= 5'

Figure-4k

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN HAMMERLY AREA — PROJECT NO. G13-165

Depth (ft.) — WBS No. S-000035-0181-4



PROFILE ALONG WHITESIDE LANE

▽ Water First Noticed

▼ Depth To Water At Completion

KEY

CH- Fat Clay		ST - Stiff
CH- Fat Clay With		VST - Very Stiff
CL- Lean Clay Wit		FRM - Firm
CL- Sandy Lean Cl		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

SCALE
Horizontal: 1"= 500'
Vertical: 1"= 5'

Figure-4I

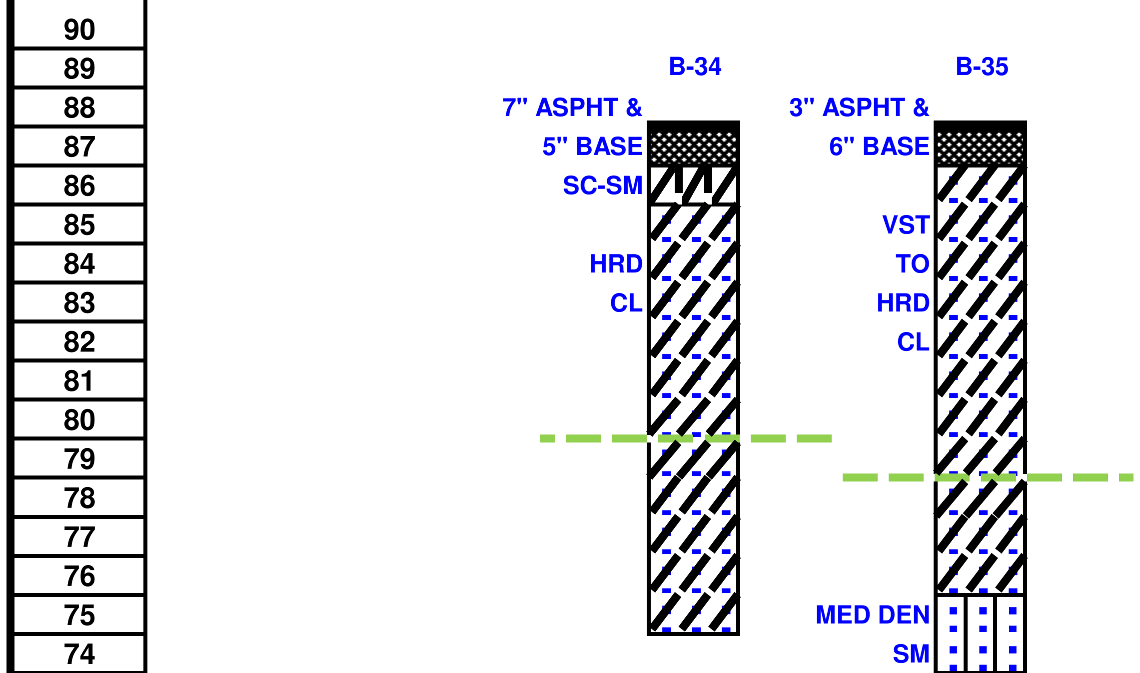
ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS

PROJECT NO. G13-165

Depth (ft.)

WBS No. S-000035-0181-4



PROFILE ALONG HANKA DRIVE

▽ Water First Noticed

▼ Depth To Water At Completion

KEY

CH- Fat Clay		ST - Stiff
CH- Fat Clay With Sand		VST - Very Stiff
CL- Lean Clay With sand		FRM - Firm
CL- Sandy Lean Clay		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

SCALE

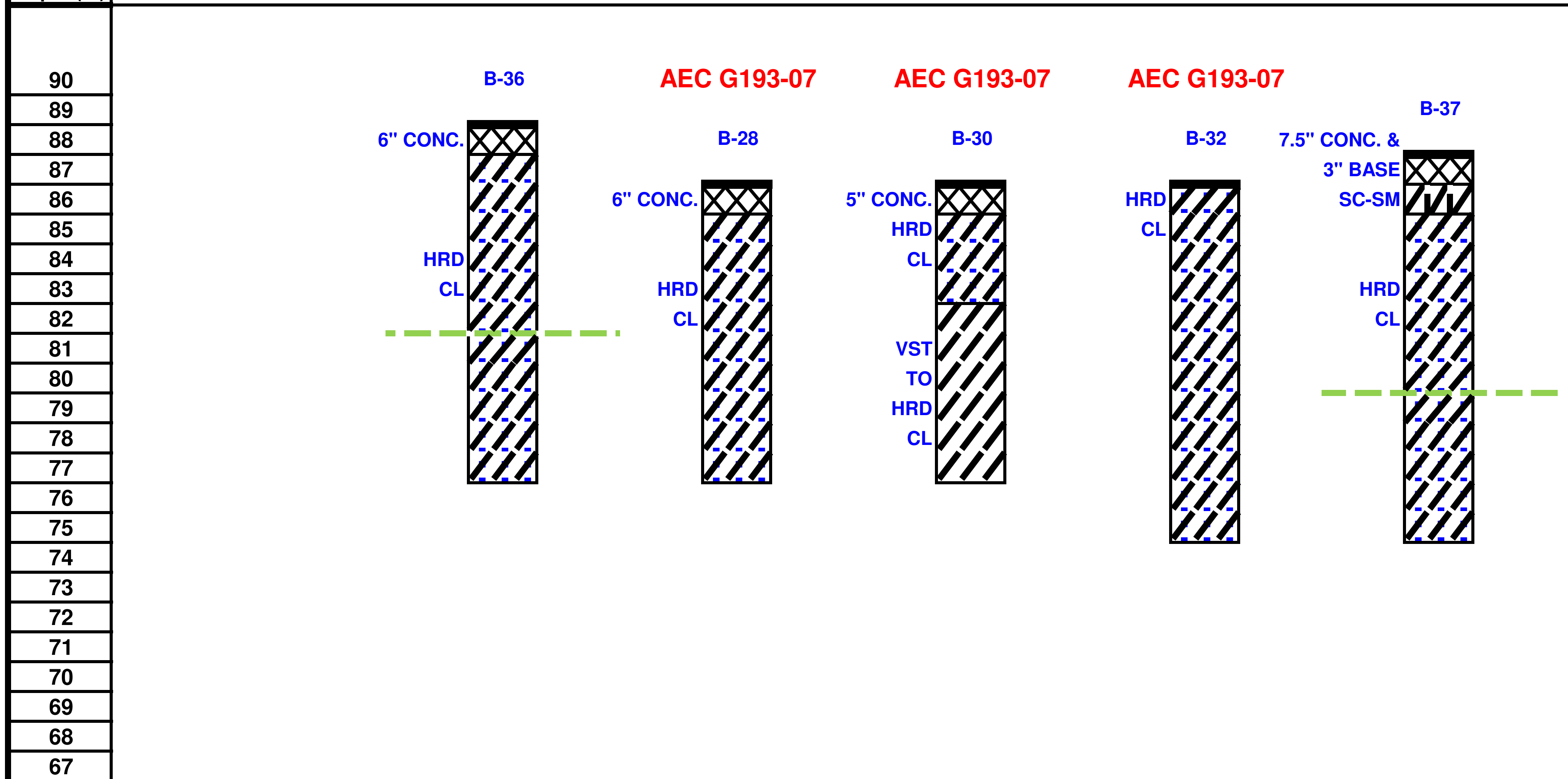
Horizontal: 1"= 500'

Vertical: 1"= 5'

ASSOCIATED TESTING LABORATORIES, INC.

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA — PROJECT NO. G13-165

WBS No. S-000035-0180-4



NOTE: BORINGS B-28, B-30 & B-32 DONE BY OTHER COMPANY IN 2007 WITH ESTIMATED ELEVATION

PROFILE ALONG PROFILE ALONG TIMBEROAK DR./HADDINGTON DR.

KEY

CH- Fat Clay		ST - Stiff
CH- Fat Clay With Sand		VST - Very Stiff
CL- Lean Clay With sand		FRM - Firm
CL- Sandy Lean Clay		HRD - Hard
SM- Silty Sand		MED DEN - Medium Dense

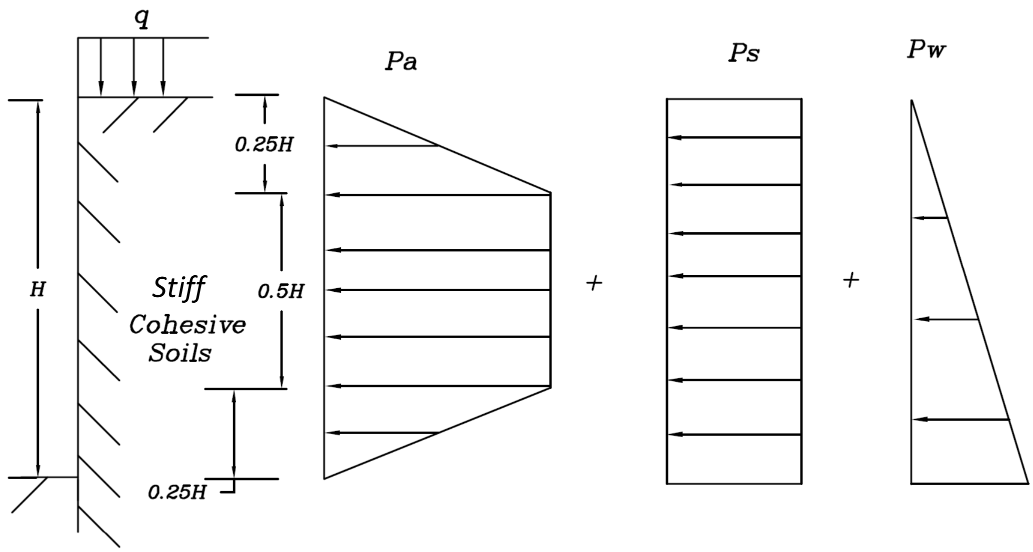
- Water First Noticed
- Depth To Water At Completion
- 24 hr. Water Level
- PZ Water Level (7-29-13)
- PZ Water Level (8-22-13)

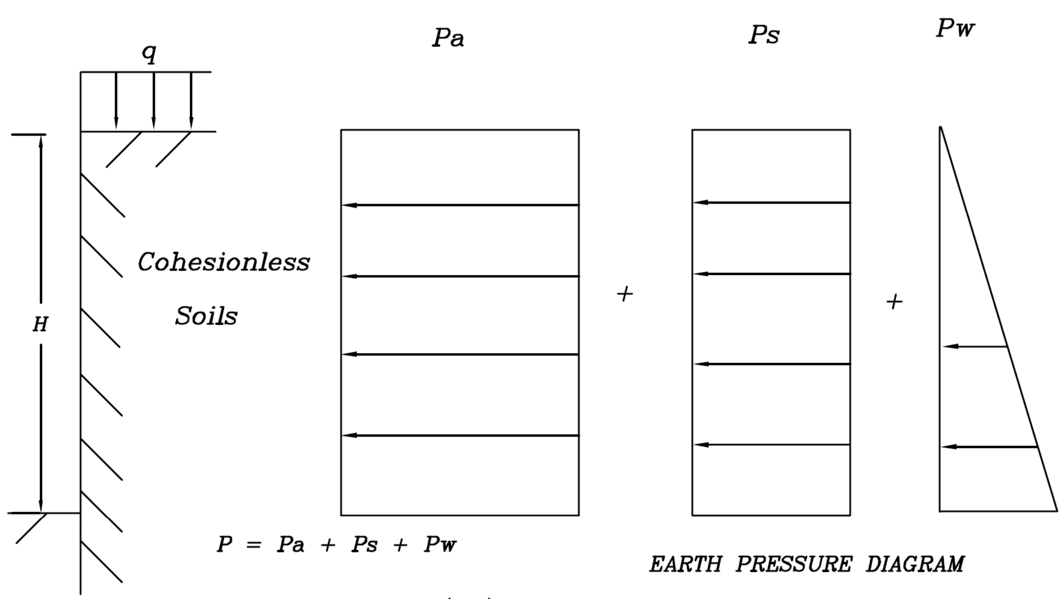
SCALE

Horizontal: 1"= 500'

Vertical: 1"= 5'

Figure-4n





$P = Pa + Ps + Pw$

EARTH PRESSURE DIAGRAM

Where P = Total lateral pressure (psf)

Pa = Active earth pressure(psf) = $K_A \gamma H = 0.4 \gamma H$ for Stiff Clays

= $0.65\ K_A \gamma H = 0.25 \gamma H$ for cohesionless Sands ($0.33 \gamma H$–for loose sand)

Ps = Lateral pressure due to surcharge load (psf) = $0.5q$ for Clays

= $0.4q$ for Sands

($0.5q$ for loose Sands)

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

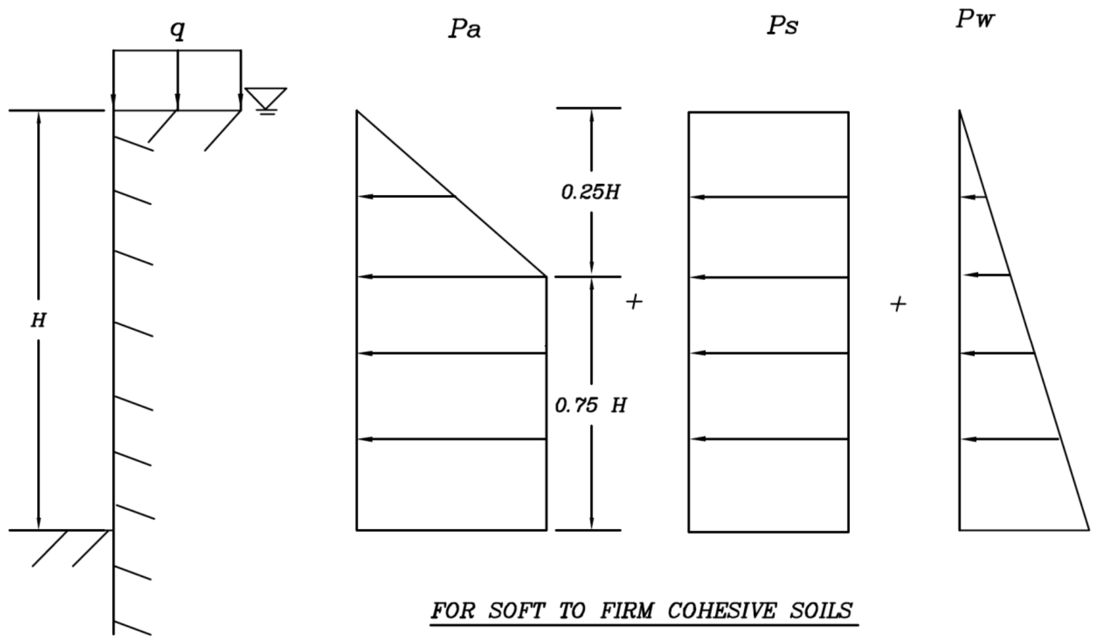
q = Surcharge load (psf) usually taken as 500 psf

γ = Submerged density of soils (pcf) = use 60 pcf (use 50 pcf for loose Sands)

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

EARTH PRESSURE DIAGRAM	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-00035-0181-4	
	PROJECT NO. : G13-165	FIGURE 5a

PST 8/28/12



FOR SOFT TO FIRM COHESIVE SOILS

Where P = Total lateral pressure (psf)

Pa = Active earth pressure(psf) = $1.0 K_a \gamma H$ for soft clays

K_a = Active Earth pressure coefficient

$$= 1 - m \frac{2 q_u}{\gamma H} = 1 - m \frac{4C}{\gamma H} \text{ (taking } C = \frac{q_u}{2}\text{)}$$

Here $m=1$ for $N<4$ and $m=0.4$ for $N>5$

N = Stability number $= \gamma H / C$

Ps = Lateral pressure due to surcharge load (psf) = K_a for clays

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

q = Surcharge load (psf) usually taken as 500 psf

γ = density of soils (pcf) = use 50 pcf below groundwater and 110 pcf above groundwater

q_u = Unconfined compressive strength, psf

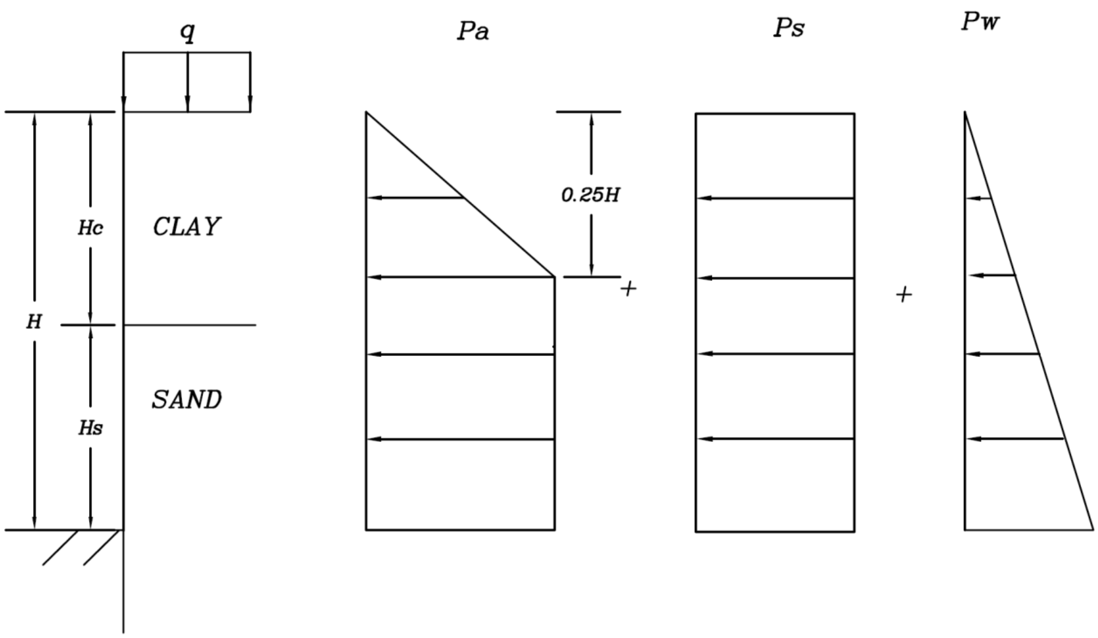
C = Undrained shear strength, psf

Note: Neglect hydrostatic pressure above groundwater level

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

EARTH PRESSURE DIAGRAM	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-00035-0181-4 PROJECT NO. : G13-165 — FIGURE 5b

PST 8/28/12



$$P = Pa + Ps + Pw$$

Where P = Total lateral pressure (psf)

Pa = Active earth pressure(psf) = $K_A \gamma H = 0.4 \gamma H$

Ps = Lateral pressure due to surcharge load (psf) = $0.5q$

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

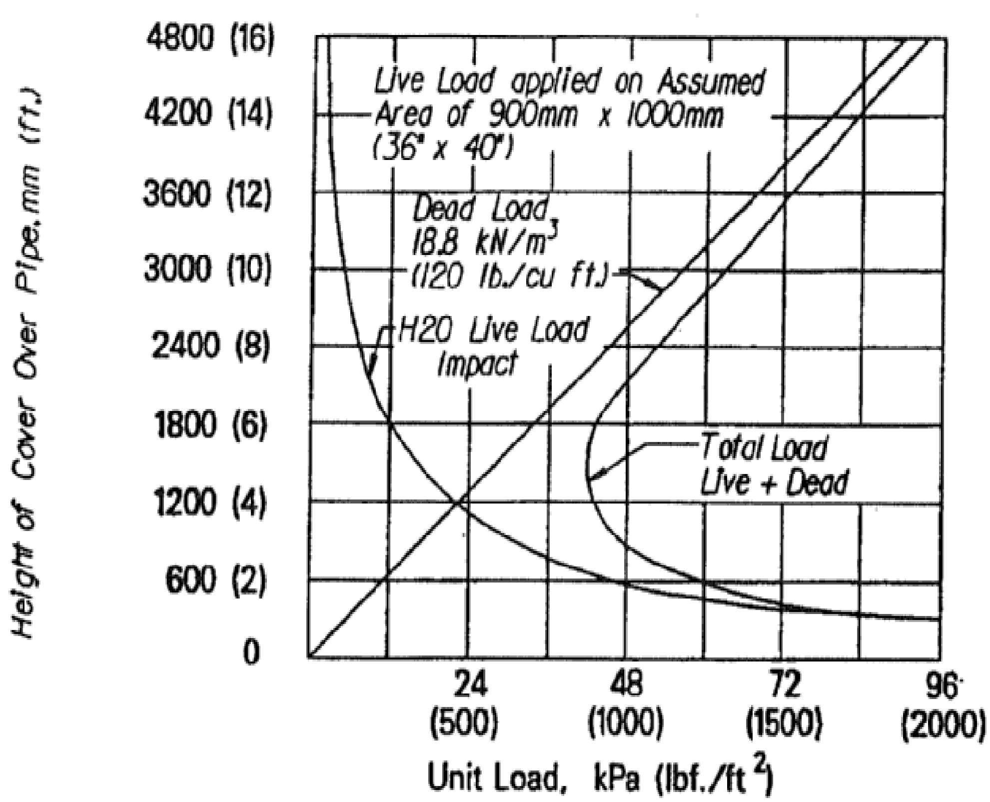
q = Surcharge load (psf) usually taken as 500 psf

γ = Submerged density of soils (pcf) = use 60 pcf

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

EARTH PRESSURE DIAGRAM	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-00035-0181-4 PROJECT NO. : G13-165 — FIGURE 5c

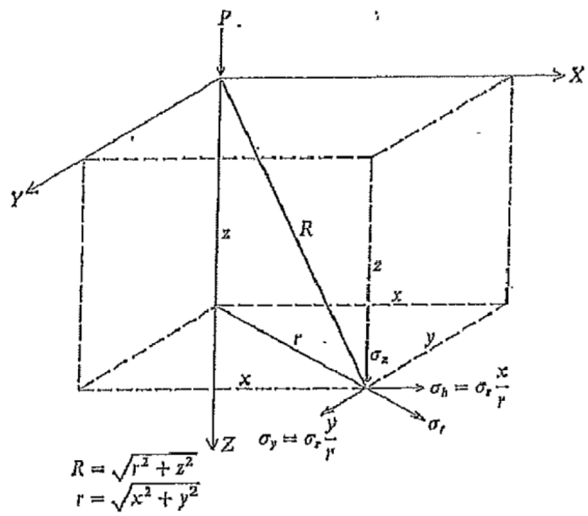
PST 8/28/12



Combined H20 highway live load and dead load is a minimum at about 1500mm (5 ft.) of cover, applied through a pavement 300mm (1 ft.) thick.

HIGHWAY LOADING ON A PIPE UNDER VARIOUS SOIL COVER	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-00035-0181-4 PROJECT NO. : G13-165 FIGURE 6

PST 8/28/12



Later Pressure, σ_r:

σ_r = (P/2π) {3r^2Z/R^5) – ([1-2μ]/R[R+z]}

For μ= 0.5,

σ_r = P/2π (2r^2z/R^5)

Vertical Pressure, σ_z :

σ_z = 3 P z^3 / 2πR^5

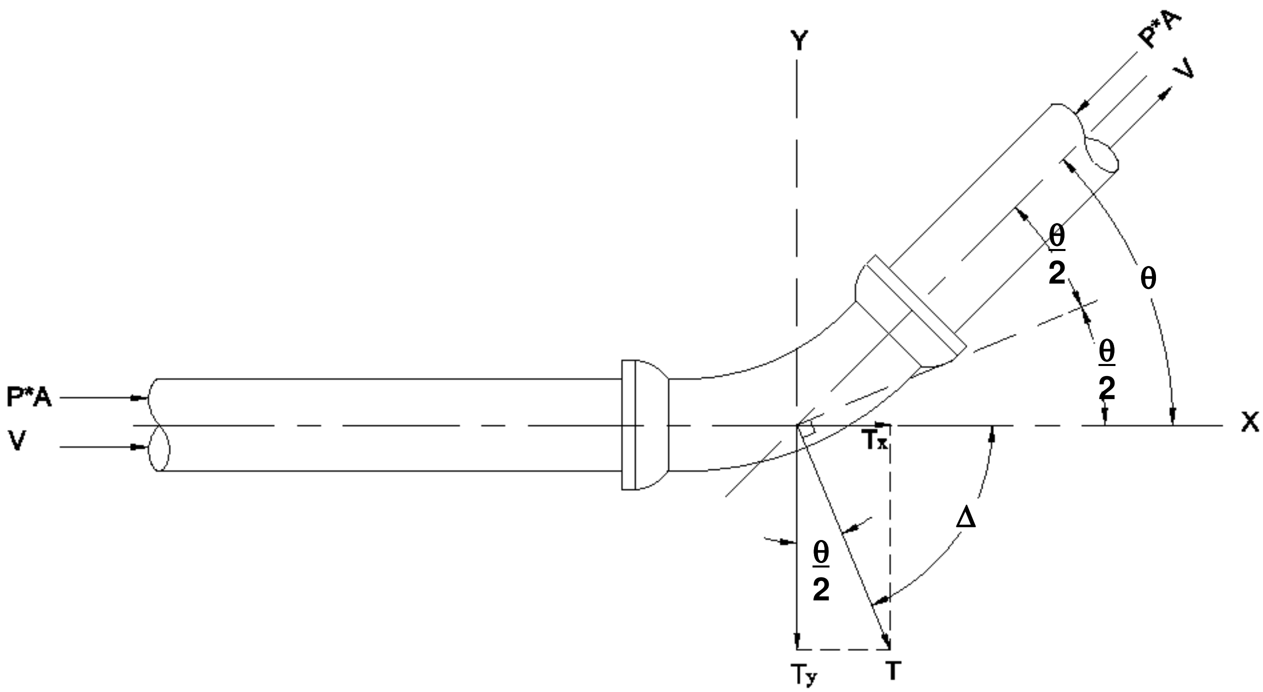
P = Point load surcharge

μ = Poisson's ratio if soils, use 0.5

X, y, z = distance in x, y and z direction, respectively

BOUSSINESQ'S EQUATION FOR POINT LOAD SURCHARGE	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-00035-0181-4 PROJECT NO. : G13-165 FIGURE 7

PST 8/28/12



$$T = 2\,P\,A \sin\frac{\theta}{2}$$

$$T_x = P\,A\,(1 - \cos\theta)$$

$$T_y = P\,A \sin\theta$$

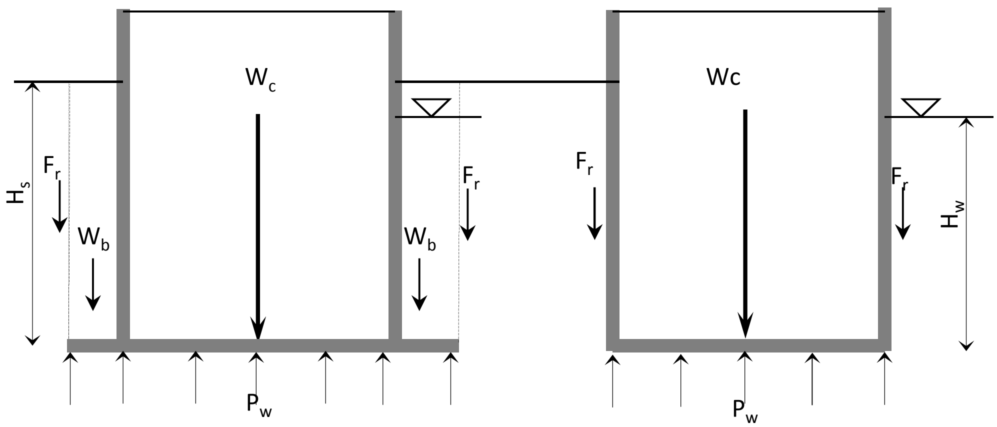
Where:

T	=	Resultant thrust force, lbs
T_x	=	Resultant thrust force component along x-axis, lbs
T_y	=	Resultant thrust force component along y-axis, lbs
P	=	Maximum sustain pressure of fluid in pipe, psi
A	=	Cross-section area of pipe, square inches
D	=	Inside diameter of pipe, inches
θ	=	Angle of the pipe bend, degrees
Δ	=	Angle between x-axis and resultant force
	=	$\tan^{-1}(T_y/T_x)$, degrees
V	=	Fluid velocity

Source: American Water Works Association, “Concrete Pressure Pipes”, AWWA Manual M9.

THRUST FORCE AT A PIPE BEND	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-00035-0181-4 PROJECT NO. : G13-165 — FIGURE 8

PST 8/28/12



Dead Weight of Structure + Dead Weight of Backfill Above Base Extension + Frictional Resistance

$P_w = H_w \gamma_w$
$F_u = A_b P_w$
$W_c/S_{fa} + W_b/S_{fb} + F_r/S_{fc} \geq F_u$
$(S_{fa} = 1.1;\ S_{fb} = 1.5;\ S_{fc} = 3.0)$

Dead Weight of Structure + Frictional Resistance

$P_w = H_w \gamma_w$
$F_u = A_b P_w$
$W_c/S_{fa} + F_r/S_{fc} \geq F_u$
$(S_{fa} = 1.1;\ S_{fc} = 3.0)$

For cohesive soils:
$F_r = \alpha c_n A_n$

For cohesionless soils,
$Fr = p_n K \tan\delta_n A_n$

Where,

H_s	=	Buried depth of wall, ft
H_w	=	Height of water table above base of structure, ft
P_w	=	Total uplift pressure = 62.4 x Hw, psf
F_u	=	Total uplift force exerted on base of structure = Pw x A_b
W_c	=	Dead weight of structure, lbs
W_b	=	Weight of backfill above base of structure, lbs
A_b	=	Area of base, ft^2
F_r	=	Friction resistance developed at the soil/wall interface, lbs
A_n	=	Contact area between the soil/wall interface in layer"n"
c_n	=	Undrained shear strength of cohesive soils at layer "n" at soil/wall interface. See individual boring logs. c_n for the top 8 ft of clays with PI higher than 20 percent should be discounted because of the shrink-swell characteristics of high plasticity clays.
α	=	Adhesion factor, to be multiplied with c_n to obtain the adhesion between the soil/wall interface. Use 0.75 if c_n is less than 0.25 tsf, use 0.67 if c_n is between 0.25 and 0.5 tsf, use 0.5 if c_n is greater than 0.5 tsf but limit the adhesion to 1.5 ksf.
K	=	Coefficient of lateral earth pressure of cohesionless soils. Use 0.4.
p_n	=	Average overburden stress at the mid-depth of cohesionless soil layer "n", psf
δ_n	=	Average frictional angle between cohesionless soil layer "n" and the walls of the structure, use 0.75 of the angle of internal friction (ϕ) of the cohesionless soil. A ϕ of 28 degrees may be used if no specific value is given.
$S_{fa,b,c}$	=	Factors of safety against buoyant uplift force.

BUOYANT UPLIFT RESISTANCE OF A BURIED STRUCTURE	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-00035-0181-4 PROJECT NO. : G13-165 FIGURE 9

LIST OF TABLES

TABLE 1

SUMMARY OF PAVEMENT MEASUREMENTS
PROPOSED WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
CITY OF HOUSTON, TEXAS
WBS NO. S-000035-0181-3
ASSOCIATED TESTING LABORATORIES, INC., JOB NUMBER G13-165

Boring Number	Boring Depth (ft)	Piezometer		Asphalt Paving (inch)	Concrete Paving (inch)	Base Material (inch)
		No.	Depth (ft)			
B-1 (PZ-1)	17	PZ-1	17	4	--	2” Crushed stone and shell
B-2	17	--	--	3	--	4” Crushed gravel
B-3	18	--	--	3.5	--	4” Crushed gravel and shell
B-4 (PZ-2)	19	PZ-2	19	8	--	3” Crushed stone and shell
B-5	17	--	--	3	--	3.5” Crushed gravel and shell
B-6	15	--	--	3.5	--	4” Crushed gravel and shell
B-7	20	--	--	3.5	--	4” Crushed stone and shell
B-8	17	--	--	3	--	4” Crushed gravel and shell
B-9	16	--	--	9	--	4” Crushed gravel and shell
B-10 (PZ-3)	17	PZ-3	17	3	--	6” Crushed gravel and shell
B-11	14	--	--	--	7.5	--
B-12	12	--	--	--	7	--
B-13	15	--	--	--	8.5	--
B-14	13	--	--	2.5	--	3” Crushed gravel and shell
B-15	13	--	--	3	--	4.5” Crushed gravel
B-16	13	--	--	--	6.5	--
B-17	13	--	--	--	6.5	--
B-18	13	--	--	--	7	--
B-19	17	--	--	1	--	8” Cement stabilized shell
B-20	12	--	--	--	5.5	--
B-21	13.5	--	--	--	6	--
B-22	15.5	--	--	5	--	6” Crushed shell
B-23	15.5	--	--	4	--	7” Crushed gravel and shell
B-24	15.5	--	--	3.5	--	7” Crushed stone
B-25	14	--	--	4	--	7” Crushed stone and shell

TABLE 1

SUMMARY OF PAVEMENT MEASUREMENTS
PROPOSED WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
CITY OF HOUSTON, TEXAS

WBS NO. S-000035-0181-3

ASSOCIATED TESTING LABORATORIES, INC., JOB NUMBER G13-165

Boring Number	Boring Depth (ft)	Piezometer		Asphalt Paving (inch)	Concrete Paving (inch)	Base Material (inch)
		No.	Depth (ft)			
B-26	14	--	--	6	--	6” Stabilized shell
B-27	14	--	--	6.5	--	9.5” Crushed gravel and shell
B-28	15.5	--	--	6	--	4” Loose shell
B-29	12	--	--	2	--	11” Stabilized shell
B-30	15	--	--	4	--	7” Crushed gravel and shell
B-31	12	--	--	4	--	6” Crushed stone and shell
B-32	12	--	--	4	--	5” Crushed gravel and shell
B-33	15.5	--	--	3	--	6” Crushed gravel and shell
B-34	13	--	--	7	--	5” Crushed gravel
B-35	14	--	--	3	--	6” Crushed gravel and shell
B-36	12	--	--	--	6	--
B-37	13	--	--	--	7.5	3” Crushed stone and shell

TABLE 2

SUMMARY OF GROUNDWATER MEASUREMENTS
PROPOSED WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
CITY OF HOUSTON,TEXAS

WBS NO. S-000035-0181-3

ATL PROJECT NO. G13-165

Boring Number	Location	Ground water during drilling	Ground water upon completion of drilling	Ground water in Piezometer (after 24 hrs)	Ground water in Piezometer (after 7 days)	Ground water in Piezometer (after 30 days)
B-1 (PZ-1)	Neuens Rd.	Dry	Dry	(7/23/2013) Dry	(7/29/2013) Dry	(8/22/2013) Dry
B-2	Neuens Rd.	Dry	Dry	--	--	--
B-3	Neuens Rd.	Dry	Dry	--	--	--
B-4 (PZ-2)	Witte Rd.	Dry	Dry	(7/23/2013) Dry	(7/29/2013) Dry	(8/22/2013) Dry
B-5	Witte Rd.	Dry	Dry	--	--	--
B-6	Witte Rd.	Dry	Dry	--	--	--
B-7	Witte Rd.	Dry	Dry	--	--	--
B-8	Witte Rd.	Dry	Dry	--	--	--
B-9	Witte Rd.	Dry	Dry	--	--	--
B-10 (PZ-3)	Witte Rd.	Dry	Dry	(7/23/2013) Dry	(7/29/2013) Dry	(8/22/2013) Dry
B-11	Long Point Rd.	Dry	Dry	--	--	--
B-12	Long Point Rd.	Dry	Dry	--	--	--
B-13	Long Point Rd.	Dry	Dry	--	--	--
B-14	Timberwood Dr.	Dry	Dry	--	--	--
B-15	Southwick St.	Dry	Dry	--	--	--
B-16	Hollow Hook Rd.	Dry	Dry	--	--	--
B-17	Timberoak Dr.(E)	Dry	Dry	--	--	--
B-18	Timberoak Dr.(E)	14’	Dry	--	--	--
B-19	Haddington Dr.	Dry	Dry	--	--	--
B-20	Haddington Dr.	Dry	Dry	--	--	--
B-21	Haddington Dr.	Dry	Dry	--	--	--
B-22	Warwana Rd.	Dry	Dry	--	--	--
B-23	Warwana Rd.	Dry	Dry	--	--	--
B-24	Briarwild Ln.	Dry	Dry	--	--	--
B-25	Briarwild Ln.	Dry	Dry	--	--	--
B-26	Lazy Oaks St.	Dry	Dry	--	--	--
B-27	Lazy Oaks St.	Dry	Dry	--	--	--
B-28	Lazy Oaks St.	Dry	Dry	--	--	--
B-29	Hazelhurst Dr.	Dry	Dry	--	--	--

TABLE 2

SUMMARY OF GROUNDWATER MEASUREMENTS
PROPOSED WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
CITY OF HOUSTON,TEXAS
WBS NO. S-000035-0181-3
ATL PROJECT NO. G13-165

Boring Number	Location	Ground water during drilling	Ground water upon completion of drilling	Ground water in Piezometer (after 24 hrs)	Ground water in Piezometer (after 7 days)	Ground water in Piezometer (after 30 days)
B-30	Hazelhurst Dr.	Dry	Dry	--	--	--
B-31	Whiteside Ln.	Dry	Dry	--	--	--
B-32	Whiteside Ln.	Dry	Dry	--	--	--
B-33	Witte Rd.	Dry	Dry	--	--	--
B-34	Longhorn Dr.	Dry	Dry	--	--	--
B-35	Hanka Dr.	Dry	Dry	--	--	--
B-36	Timberoak Dr.	Dry	Dry	--	--	--
B-37	Haddington Dr.(W)	Dry	Dry	--	--	--

TABLE 3

ASSOCIATED TESTING LABORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052 TEL: (713) 748-3717 FAX: (713) 748-3748	PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA COH WBS NO: S-000035-0181-3 CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	TYPE OF MATERIAL
B-1	1	0-2	UD		14		38	17	21	52				3.00	Silty-Clayey Sand (SC-SM) fill
	2	2-4	SS	4	12										Silty Sand (SM)
	3	4-6	SS	12	12										Silty Sand (SM)
	4	6-8	SS	11	11										Silty Sand (SM)
	5	8-10	UD		17	101	29	15	14	51	0.15			0.50	Sandy Lean Clay (CL)
	6	10-12	UD		17									1.00	Sandy Lean Clay (CL)
	7	12-14	SS	8	17										Silty Sand (SM)
	8	14-16	SS	21	20										Silty Sand (SM)
	9	16-17	UD		13		36	17	19					4.50	Sandy Lean Clay (CL)
B-2	1	0-2	UD		15		25	15	10	51				1.00	Sandy Lean Clay (CL) fill
	2	2-4	UD		18									1.00	Sandy Lean Clay (CL) fill
	3	4-6	UD		17									1.00	Sandy Lean Clay (CL) fill
	4	6-8	UD		19									1.00	Sandy Lean Clay (CL) fill
	5	8-10	UD		17									1.00	Sandy Lean Clay (CL)
	6	10-12	UD		19									1.00	Sandy Lean Clay (CL)
	7	12-14	UD		18		24	15	9	51				0.75	Sandy Lean Clay (CL)
	8	14-16	UD		15	120					1.15			3.50	Sandy Lean Clay (CL)
	9	16-17	UD		15									3.00	Sandy Lean Clay (CL)
B-3	1	0-2	UD		14									2.00	Sandy Lean Clay (CL)
	2	2-4	UD		14		31	16	15					1.50	Sandy Lean Clay (CL)
	3	4-6	UD		18									2.00	Sandy Lean Clay (CL)
	4	6-8	UD		17									1.50	Sandy Lean Clay (CL)
	5	8-10	UD		25									2.00	Sandy Lean Clay (CL)
	6	10-12	UD		17									1.50	Poorly Graded Sand with Silt (SP-SM)
	7	12-14	UD		17	114					0.80			2.00	Sandy Lean Clay (CL)
	7	14-16	UD		15		37	17	20	54				3.00	Sandy Lean Clay (CL)
	8	16-18	UD		15									4.50	Sandy Lean Clay (CL)

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.	PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052	COH WBS NO: S-000035-0181-3
TEL: (713) 748-3717 FAX: (713) 748-3748	CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-4	1	0-2	AU		12		19	14	5	48					Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		11									1.00	Sandy Lean Clay (CL) fill
	3	4-6	UD		17									1.50	Sandy Lean Clay (CL)
	4	6-8	UD		18									2.00	Sandy Lean Clay (CL)
	5	8-10	UD		17		43	18	25	66				2.00	Sandy Lean Clay (CL)
	6	10-12	UD		18	112					1.15			3.50	Sandy Lean Clay (CL)
	7	12-14	UD		24									3.00	Sandy Lean Clay (CL)
	8	14-16	UD		24	102					1.22 (0.72)	1.22(0.72)		3.00	Sandy Lean Clay (CL)
	9	16-18	UD		21		30	16	14					0.50	Sandy Lean Clay (CL)
	10	18-19	UD		15									3.50	Sandy Lean Clay (CL)
B-5	1	0-2	SS	7	9										Silty Sand (SM)
	2	2-4	UD		10		24	15	9					1.00	Sandy Lean Clay (CL)
	3	4-6	UD		18									1.00	Sandy Lean Clay (CL)
	4	6-8	UD		15									3.50	Sandy Lean Clay (CL)
	5	8-10	UD		15						1.25			3.00	Sandy Lean Clay (CL)
	6	10-12	UD		31									0.75	Sandy Lean Clay (CL)
	7	12-14	UD		21		48	18	20					3.00	Sandy Lean Clay (CL)
	8	14-16	UD		20	110					1.50			4.00	Sandy Lean Clay (CL)
	9	16-17	UD		18									4.00	Sandy Lean Clay (CL)
B-6	1	0-2	UD		10		25	15	10	51				2.00	Sandy Lean Clay (CL)
	2	2-4	UD		12									3.25	Sandy Lean Clay (CL)
	3	4-6	UD		14									3.75	Sandy Lean Clay (CL)
	4	6-8	UD		17									3.50	Sandy Lean Clay (CL)
	5	8-10	UD		17									2.00	Poorly Graded Sand with Silt (SP-SM)
	6	10-12	UD		15		29	15	14	54				2.00	Sandy Lean Clay (CL)
		12-14	UD		15	118					0.90			2.25	Sandy Lean Clay (CL)
	7	14-15	UD		13									2.75	Sandy Lean Clay (CL)

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.	PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS AREA
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052	COH WBS NO: S-000035-0181-3
TEL: (713) 748-3717 FAX: (713) 748-3748	CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-7	1	0-2	UD		9									2.00	Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		13		36	17	19	52				2.00	Sandy Lean Clay (CL)
	3	4-6	UD		14									2.50	Sandy Lean Clay (CL)
	4	6-8	UD		15									2.75	Sandy Lean Clay (CL)
	5	8-10	UD		14									3.00	Sandy Lean Clay (CL)
	6	10-12	UD		15		32	16	16	51				3.00	Sandy Lean Clay (CL)
	7	12-14	UD		11	103					0.25			1.00	Sandy Lean Clay (CL)
	8	14-16	SS	18	7										Silty Sand (SM)
	9	16-18	SS	21	9										Silty Sand (SM)
	10	18-20	SS	23	9										Silty Sand (SM)
B-8	1	0-2	AU		10										Silty Sand (SM)
	2	2-4	UD		17									1.00	Sandy Lean Clay (CL)
	3	4-6	UD		17		36	17	19	52				1.00	Sandy Lean Clay (CL)
	4	6-8	UD		14									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		20									3.50	Sandy Lean Clay (CL)
	6	10-12	UD		18									0.75	Sandy Lean Clay (CL)
	7	12-14	UD		14	114					1.10			3.50	Sandy Lean Clay (CL)
	8	14-16	UD		7		20	14	6	35				1.00	Clayey Sand (SC)
	9	16-17	UD		21									3.00	Sandy Lean Clay (CL)
B-9	1	0-2	AU		10										Silty Sand (SM)
	2	2-4	UD		14		35	16	19	52				2.00	Sandy Lean Clay (CL)
	3	4-6	UD		17									3.00	Sandy Lean Clay (CL)
	4	6-8	UD		16									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		16									2.75	Poorly Graded Sand with Silt (SP-SM)
	6	10-12	UD		17									3.00	Sandy Lean Clay (CL)
	7	12-14	UD		15		36	17	19	51				2.50	Sandy Lean Clay (CL)
	8	14-16	UD		17	113					0.55			2.00	Sandy Lean Clay (CL)

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052 TEL: (713) 748-3717 FAX: (713) 748-3748	PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS AREA COH WBS NO: S-000035-0181-3 CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-10	1	0-2	SS		7										Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		10		24	15	9	51				1.75	Sandy Lean Clay (CL) fill
	3	4-6	UD		16									3.00	Sandy Lean Clay (CL)
	4	6-8	UD		15									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		15	110					0.85			2.50	Sandy Lean Clay (CL)
	6	10-12	UD		12		25	15	10	52				3.50	Sandy Lean Clay (CL)
	7	12-14	UD		17	111						1.17(0.65)		4.00	Sandy Lean Clay (CL)
	8	14-16	SS	22	15										Silty Sand (SM)
	9	16-17	UD		21		46	18	28					2.00	Sandy Lean Clay (CL)
B-11	1	0-2	AU		17										Sandy Lean Clay (CL)
	2	2-4	UD		20		37	17	20	51				1.00	Sandy Lean Clay (CL)
	3	4-6	UD		18									1.00	Sandy Lean Clay (CL)
	4	6-8	UD		19									1.00	Sandy Lean Clay (CL)
	5	8-10	UD		17									2.50	Sandy Lean Clay (CL)
	6	10-12	UD		17	111					1.15			3.50	Sandy Lean Clay (CL)
	7	12-14	UD		17		37	17	20	53				0.75	Sandy Lean Clay (CL)
B-12	1	0-2	UD		22		30	16	14					1.50	Sandy Lean Clay (CL)
	2	2-4	UD		20									2.00	Sandy Lean Clay (CL)
	3	4-6	UD		19									2.00	Sandy Lean Clay (CL)
	4	6-8	UD		19	109					0.95			2.50	Sandy Lean Clay (CL)
	5	8-10	UD		17		49	19	30	54				3.00	Sandy Lean Clay (CL)
	6	10-12	UD		17									3.00	Sandy Lean Clay (CL)

Legend:

UD - Undisturbed Sample Extruded in Field

UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field

SS - Split Spoon Sample
SPT - Standard Penetration Test

Poorly
Graded

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.	PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS AREA
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052	COH WBS NO: S-000035-0181-3
TEL: (713) 748-3717 FAX: (713) 748-3748	CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-13	1	0-2	UD		19									2.00	Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		24		59		39	62				2.00	Sandy Fat Clay (CH)
	3	4-6	UD		17									3.50	Sandy Fat Clay (CH)
	4	6-8	UD		15									4.50	Sandy Fat Clay (CH)
	5	8-10	UD		16	116					2.05			4.50	Sandy Fat Clay (CH)
	6	10-12	UD		18		50	19	31	51				4.00	Sandy Fat Clay (CH)
	7	12-14	UD		17	111						1.93(0.65)		3.50	Sandy Fat Clay (CH)
	8	14-15	UD		19									3.50	Sandy Fat Clay (CH)
B-14	1	0-2	AU		13		25	15	10	52					Sandy Lean Clay (CL)
	2	2-4	UD		12									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		9									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		10									1.00	Sandy Lean Clay (CL)
	5	8-10	UD		10	122					2.25			1.00	Sandy Lean Clay (CL)
	6	10-12	UD		10		40	17	23	51				4.50	Sandy Lean Clay (CL)
	7	12-13	UD		11									4.50	Sandy Lean Clay (CL)
														0.75	
B-15	1	0-2	AU		5										Silty Sand (SM)
	2	2-4	UD		8		28	15	13	51				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		6									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		9									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		9	117	33	16	17		2.05			4.50	Sandy Lean Clay (CL)
	6	10-12	UD		15									4.50	Sandy Lean Clay (CL)
	7	123	UD		17									3.00	Sandy Lean Clay (CL)

Legend:

UD - Undisturbed Sample Extruded in Field

UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field

SS - Split Spoon Sample
SPT - Standard Penetration Test

Poorly
Graded

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
COH WBS NO: S-000035-0181-3
CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-16	1	0-2	UD		16		19	14	5	41				1.00	Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		11									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		12									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		13									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		16	110					1.45			3.50	Sandy Lean Clay (CL)
	6	10-12	UD		14		38	17	21					3.00	Sandy Lean Clay (CL)
	7	12-13	UD		11									4.00	Sandy Lean Clay (CL)
B-17	1	0-2	UD		24									0.50	Sandy Lean Clay (CL)
	2	2-4	UD		20		39	17	22	52				0.50	Sandy Lean Clay (CL)
	3	4-6	UD		21									1.00	Sandy Lean Clay (CL)
	4	6-8	UD		18									1.50	Sandy Lean Clay (CL)
	5	8-10	UD		17		44	18	26					1.00	Sandy Lean Clay (CL)
	6	10-12	UD		18	107					0.30			1.00	Sandy Lean Clay (CL)
	7	12-134	UD		18									3.50	Sandy Lean Clay (CL)
B-18	1	0-2	UD		21		41	17	24	66				0.75	Sandy Lean Clay (CL)
	2	2-4	UD		18									0.50	Sandy Lean Clay (CL)
	3	4-6	UD		15									3.50	Sandy Lean Clay (CL)
	4	6-8	UD		22									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		12	109					1.55			4.00	Sandy Lean Clay (CL)
	6	10-12	UD		22		46	18	28					3.50	Sandy Lean Clay (CL)
	7	12-13	UD		20									2.50	Sandy Lean Clay (CL)

Legend:
UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed
AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test
Poorly Graded

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
COH WBS NO: S-000035-0181-3
CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample NO.	Sample DEPTH (ft)	Sample TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	TYPE OF MATERIAL
B-19	1	0-2	UD		18									1.00	Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		17		30	16	14	51				0.50	Sandy Lean Clay (CL)
	3	4-6	UD		14									4.00	Sandy Lean Clay (CL)
	4	6-8	UD		16									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		14	111					0.95			2.50	Sandy Lean Clay (CL)
	6	10-12	UD		8									1.00	Sandy Lean Clay (CL)
	7	12-14	SS	15	14					15					Silty Sand (SM)
	8	14-16	UD		16	116						2.60 (0.72)		4.00	Sandy Lean Clay (CL)
	9	161	UD		16									4.00	Sandy Lean Clay (CL)
B-20	1	0-2	UD		6									4.50	Sandy Lean Clay (CL)
	2	2-4	UD		5		30	16	14	56				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		8									1.00	Sandy Lean Clay (CL)
	4	6-8	UD		8									1.00	Sandy Lean Clay (CL)
	5	8-10	UD		11	122					2.25			4.50	Sandy Lean Clay (CL)
	6	10-12	UD		11		34	16	18					4.50	Sandy Lean Clay (CL)
B-21	1	0-2	UD		16		30	16	14	60				2.00	Sandy Lean Clay (CL)
	2	2-4	UD		15									2.00	Sandy Lean Clay (CL)
	3	4-6	UD		15									3.50	Sandy Lean Clay (CL)
	4	6-8	UD		17	114					0.65			2.00	Sandy Lean Clay (CL)
	5	8-10	UD		16		31	16	15					2.00	Sandy Lean Clay (CL)
	6	10-12	SS	19	6					18					Silty Sand (SM
	7	12-13.5	SS	19	6										Silty Sand (SM

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

Poorly Graded

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.

3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052

TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA

COH WBS NO: S-000035-0181-3

CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO- METER	
B-22	1	0-2	UD		25									1.50	Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		19		56	20	36	67				2.75	Sandy Fat Clay (CH)
	3	4-6	UD		14									3.50	Sandy Fat Clay (CH)
	4	6-8	UD		15									3.00	Sandy Fat Clay (CH)
	5	8-10	UD		17		45	18	27	59				3.50	Sandy Lean Clay (CL)
	6	10-12	UD		18	110					1.00			3.50	Sandy Lean Clay (CL)
	7	12-14	SS	9	14										Silty Sand (SM)
	8	14-15.5	SS	9	15									`	Silty Sand (SM)
B-23	1	0-2	UD		8									4.50	Sandy Lean Clay (CL)
	2	2-4	UD		9		33	16	17	57				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		10									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		13									1.00	Sandy Lean Clay (CL)
	5	8-10	UD		14									1.00	Sandy Lean Clay (CL)
	6	10-12	UD		15	111	44	18	26	53	2.15			4.50	Sandy Lean Clay (CL)
	7	12-14	UD		13									1.50	Sandy Lean Clay (CL)
	8	14-15.5	SS	15	8									0.75	Silty Sand (SM)
B-24	1	0-2	UD		21		56	20	36	59				1.00	Sandy Fat Clay (CH)
	2	2-4	UD		18									2.50	Sandy Fat Clay (CH)
	3	4-6	UD		14									4.00	Sandy Fat Clay (CH)
	4	6-8	UD		14									4.50	Sandy Fat Clay (CH)
	5	8-10	UD		12	123					2.25			4.50	Sandy Lean Clay (CL)
	6	10-12	UD		14	122						3.05 (0.58)		4.50	Sandy Lean Clay (CL)
	7	12-14	UD		14		39	17	22					2.50	Sandy Lean Clay (CL)
	8	14-15.5	SS	16	4					16					Poorly Graded Sand with Silt (SP-SM)

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.	**PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA**
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052	**COH WBS NO: S-000035-0181-3**
TEL: (713) 748-3717 FAX: (713) 748-3748	**CONSULTANT PROJECT NUMBER: G13-165**

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-25	1	0-2	UD		21									1.50	Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		16		34	16	18	60				1.50	Sandy Lean Clay (CL)
	3	4-6	UD		14									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		13									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		15									3.75	Sandy Lean Clay (CL)
	6	10-12	UD		13		31	16	15	52				4.00	Sandy Lean Clay (CL)
	7	12-14	UD		10	110					0.55			2.00	Sandy Lean Clay (CL)
B-26	1	0-2	UD		23									1.00	Sandy Fat Clay (CH)
	2	2-4	UD		22		50	19	31	56				1.00	Sandy Fat Clay (CH)
	3	4-6	UD		15									3.00	Sandy Fat Clay (CH)
	4	6-8	UD		15									3.50	Sandy Fat Clay (CH)
	5	8-10	UD		15	118					1.90			1.00	Sandy Fat Clay (CH)
	6	10-12	UD		15		30	16	14	54				1.00	Sandy Lean Clay (CL)
	7	12-14	UD		15									1.75	Sandy Lean Clay (CL)
B-27	1	0-2	UD		9									0.75	Sandy Lean Clay (CL)
	2	2-4	UD		11									2.00	Sandy Lean Clay (CL)
	3	4-6	UD		13		25	15	10	51				3.50	Sandy Lean Clay (CL)
	4	6-8	UD		13									4.00	Sandy Lean Clay (CL)
	5	8-10	UD		13									3.00	Sandy Lean Clay (CL)
	6	10-12	UD		12		30	16	14	52				4.00	Sandy Lean Clay (CL)
	7	12-14	UD		11	109					0.60			2.00	Sandy Lean Clay (CL)

Legend:

UD - Undisturbed Sample Extruded in Field

UL - Undisturbed Sample Extruded in Lab

Designates consolidation test Performed

AG - Auger Cutting in Field

SS - Split Spoon Sample

SPT - Standard Penetration Test

Poorly Graded

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052
TEL: (713) 748-3717 FAX: (713) 748-3748

PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
COH WBS NO: S-000035-0181-3
CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-28	1	0-2	UD		11		18	14	4	37				1.50	Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		12									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		15									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		15	118					1.75			4.00	Sandy Lean Clay (CL)
	5	8-10	UD		13		35	16	19					2.50	Sandy Lean Clay (CL)
	6	10-12	UD		13									4.50	Sandy Lean Clay (CL)
	7	12-14	UD		12	119						1.45 (0.65)		4.50	Sandy Lean Clay (CL)
	8	14-15.5	SS	14	4										Silty Sand (SM)
B-29	1	0-2	AU		9		17	14	3	43					Sity Sand (SM)
	2	2-4	UD		18									2.75	Sandy Lean Clay (CL)
	3	4-6	UD		14									3.50	Sandy Lean Clay (CL)
	4	6-8	UD		12									1.00	Sandy Lean Clay (CL)
	5	8-10	UD		14		41	17	24					1.00	Sandy Lean Clay (CL)
	6	10-12	UD		15	117					1.10			3.50	Sandy Lean Clay (CL)
B-30	1	0-2	AU		3									0.75	Silty Sand (SM)
	2	2-4	SS	31	4					29					Silty Sand (SM)
	3	4-6	UD		11		48	18	30	51				4.50	Sandy Lean Clay (CL)
	4	6-8	UD		11									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		10									4.50	Sandy Lean Clay (CL)
	6	10-12	UD		11	121								4.50	Sandy Lean Clay (CL)
	7	12-14	UD		10		36	17	19					4.50	Sandy Lean Clay (CL)
	8	14-15	UD		25									2.75	Sandy Lean Clay (CL)

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

Poorly Graded

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC.	PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052	COH WBS NO: S-000035-0181-3
TEL: (713) 748-3717 FAX: (713) 748-3748	CONSULTANT PROJECT NUMBER: G13-165

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-31	1	0-2	UD		17		35	16	19	52				2.00	Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		18									1.75	Sandy Lean Clay (CL)
	3	4-6	UD		13									4.00	Sandy Lean Clay (CL)
	4	6-8	UD		13		38	17	21					3.50	Sandy Lean Clay (CL)
	5	8-10	UD		14	114					1.10			4.00	Sandy Lean Clay (CL)
	6	10-12	UD		18									3.75	Sandy Lean Clay (CL)
B-32	1	0-2	UD		5										Silty Sand (SM)
	2	2-4	UD		13		42	18	24	52				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		11									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		10									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		19		39	17	22					4.50	Sandy Lean Clay (CL)
	6	10-12	UD		9	120					2.15			1.00	Sandy Lean Clay (CL)
B-33	1	0-2	AU		7										Silty Sand (SM)
	2	2-4	UD		15									3.25	Sandy Lean Clay (CL)
	3	4-6	UD		13		43	18	25	52				0.75	Sandy Lean Clay (CL)
	4	6-8	UD		12	122					1.95			4.25	Sandy Lean Clay (CL)
	5	8-10	UD		14									3.75	Sandy Lean Clay (CL)
	6	10-12	UD		14	118	47	18	29			2.54(0.58)		3.50	Sandy Lean Clay (CL)
	7	12-14	SS	19	9					15					Silty Sand (SM)
	8	14-15.5	SS	21	8										Silty Sand (SM)

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

Poorly Graded

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052 TEL: (713) 748-3717 FAX: (713) 748-3748	**PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA** **COH WBS NO: S-000035-0181-3** **CONSULTANT PROJECT NUMBER: G13-165**

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-34	1	0-2	AU		4		19	14	5	41					Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		8									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		12									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		12									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		17									4.50	Sandy Lean Clay (CL)
	6	10-12	UD		13	109					1.00			3.50	Sandy Lean Clay (CL)
	7	12-13	UD		12		30	16	14	51				2.75	Sandy Lean Clay (CL)
B-35	1	0-2	UD		14									4.00	Sandy Lean Clay (CL)
	2	2-4	UD		12		32	16	16	51				4.50	Sandy Lean Clay (CL)
	3	4-6	UD		14									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		13									4.50	Sandy Lean Clay (CL)
	5	8-10	UD		14	117					1.90			1.00	Sandy Lean Clay (CL)
	6	10-12	UD		11		33	16	17					1.00	Sandy Lean Clay (CL)
	7	12-14	SS	20	6					23					Silty Sand (SM)
B-36	1	0-2	UD		13		31	16	15	69				0.75	Sandy Lean Clay (CL)
	2	2-4	UD		11									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		10									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		10	125					1.25			4.50	Sandy Lean Clay (CL)
	5	8-10	UD		13		49	19	30	67				4.50	Sandy Lean Clay (CL)
	6	10-12	UD		15									4.50	Sandy Lean Clay (CL)

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

Poorly Graded

TABLE 3 (cont'd)

ASSOCIATED TESTING LABORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS 77052 TEL: (713) 748-3717 FAX: (713) 748-3748	**PROJECT NAME : WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA** **COH WBS NO: S-000035-0181-3** **CONSULTANT PROJECT NUMBER: G13-165**

BORING NO.	Sample			SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	Atterberg Limits			PERCENT PASSING SIEVE 200 (%)	UNDRAINED SHEAR STRENGTH (TSF)				TYPE OF MATERIAL
	NO.	DEPTH (ft)	TYPE				LL	PL	PI		UNCONFINED COMPRESSION TEST (TSF)	UU TEST (CONFINING PRESSURE) (TSF)	TORVANE	POCKET PENETRO-METER	
B-37	1	0-2	AU		5		20	14	6	42					Silty-Clayey Sand (SC-SM) fill
	2	2-4	UD		8									4.50	Sandy Lean Clay (CL)
	3	4-6	UD		9									4.50	Sandy Lean Clay (CL)
	4	6-8	UD		9	126					2.25			4.50	Sandy Lean Clay (CL)
	5	8-10	UD		9									4.50	Sandy Lean Clay (CL)
	6	10-12	UD		11	118						2.86 (0.58)		4.50	Sandy Lean Clay (CL)
	7	12-13	UD		8		23	15	8					4.50	Sandy Lean Clay (CL)
														1.00	
														1.00	
														0.75	

Legend:

UD - Undisturbed Sample Extruded in Field
UL - Undisturbed Sample Extruded in Lab
Designates consolidation test Performed

AG - Auger Cutting in Field
SS - Split Spoon Sample
SPT - Standard Penetration Test

Poorly Graded

TABLE 4.1

Marston Soil Coefficients (C_d) for Trench Conduits

A = $K\mu'$ = •1924 Granular materials without cohesion
B = $K\mu'$ = •165 Maximum for sand and gravel
C = $K\mu'$ = •150 Maximum for saturated top soil
D = $K\mu'$ = •130 Ordinary maximum for clay
E = $K\mu'$ = •110 Maximum for saturated clay

H/B_d	A	B	C	D	E
0.05	0.050	0.050	0.050	0.050	0.050
0.10	0.098	0.098	0.099	0.099	0.099
0.15	0.146	0.146	0.147	0.147	0.148
0.20	0.192	0.194	0.194	0.195	0.196
0.25	0.238	0.240	0.241	0.242	0.243
0.30	0.283	0.286	0.287	0.289	0.290
0.35	0.327	0.331	0.332	0.335	0.337
0.40	0.371	0.375	0.377	0.380	0.383
0.45	0.413	0.418	0.421	0.425	0.428
0.50	0.455	0.461	0.464	0.469	0.473
0.55	0.496	0.503	0.507	0.512	0.518
0.60	0.536	0.544	0.549	0.555	0.562
0.65	0.575	0.585	0.591	0.598	0.606
0.70	0.614	0.625	0.631	0.640	0.649
0.75	0.651	0.664	0.672	0.681	0.691
0.80	0.689	0.703	0.711	0.722	0.734
0.85	0.725	0.741	0.750	0.763	0.775
0.90	0.761	0.779	0.789	0.802	0.817
0.95	0.796	0.816	0.827	0.842	0.857

H/B_d	A	B	C	D	E
3.00	1.780	1.904	1.978	2.083	2.196
3.10	1.810	1.941	2.018	2.128	2.247
3.20	1.840	1.976	2.057	2.172	2.297
3.30	1.869	2.010	2.095	2.215	2.346
3.40	1.896	2.044	2.131	2.257	2.394
3.50	1.923	2.076	2.167	2.298	2.441
3.60	1.948	2.107	2.201	2.338	2.487
3.70	1.973	2.137	2.235	2.376	2.531
3.80	1.997	2.166	2.267	2.414	2.575
3.90	2.019	2.194	2.299	2.451	2.618
4.00	2.041	2.221	2.329	2.487	2.660
4.10	2.062	2.247	2.359	2.522	2.701
4.20	2.082	2.273	2.388	2.556	2.741
4.30	2.102	2.297	2.416	2.589	2.780
4.40	2.121	2.321	2.443	2.621	2.819
4.50	2.139	2.344	2.469	2.652	2.856
4.60	2.156	2.366	2.495	2.683	2.893
4.70	2.173	2.388	2.520	2.713	2.929
4.80	2.189	2.409	2.543	2.742	2.964

CONCRETE PRESSURE PIPE

Source: American Water Works Association, Manual of Water Supply Practices, “Concrete Pressure Pipe, AMMA M9

MARSTON SOIL COEFFICIENTS (C_d) FOR TRENCH CONDUITS	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS NO. S-00035-0181-4	
	PROJECT NO. : G13-165	TABLE 4 (1 of 2)

TABLE 4.1 *(cont)*

H/B_d	A	B	C	D	E
1.00	0.830	0.852	0.864	0.881	0.898
1.05	0.864	0.887	0.901	0.919	0.938
1.10	0.897	0.922	0.937	0.957	0.977
1.15	0.929	0.957	0.973	0.994	1.016
1.20	0.961	0.991	1.008	1.031	1.055
1.25	0.992	1.024	1.042	1.067	1.093
1.30	1.023	1.057	1.076	1.103	1.131
1.35	1.053	1.089	1.110	1.139	1.168
1.40	1.082	1.121	1.143	1.173	1.205
1.45	1.111	1.152	1.176	1.208	1.241
1.50	1.140	1.183	1.208	1.242	1.278
1.55	1.167	1.213	1.240	1.276	1.313
1.60	1.195	1.243	1.271	1.309	1.349
1.65	1.221	1.272	1.301	1.342	1.384
1.70	1.248	1.301	1.332	1.374	1.418
1.75	1.273	1.329	1.361	1.406	1.452
1.80	1.299	1.357	1.391	1.437	1.486
1.85	1.323	1.385	1.420	1.469	1.520
1.90	1.348	1.412	1.448	1.499	1.553
1.95	1.372	1.438	1.476	1.530	1.586
2.00	1.395	1.464	1.504	1.560	1.618
2.10	1.440	1.515	1.558	1.618	1.682
2.20	1.484	1.564	1.610	1.675	1.744
2.30	1.526	1.612	1.661	1.731	1.805
2.40	1.567	1.658	1.711	1.785	1.865
2.50	1.606	1.702	1.759	1.838	1.923
2.60	1.643	1.745	1.805	1.890	1.980
2.70	1.679	1.787	1.850	1.940	2.036
2.80	1.714	1.827	1.894	1.989	2.090
2.90	1.747	1.867	1.937	2.037	2.144

H/B_d	A	B	C	D	E
4.90	2.204	2.429	2.567	2.770	2.999
5.00	2.219	2.448	2.590	2.798	3.032
5.10	2.234	2.467	2.612	2.825	3.065
5.20	2.247	2.486	2.633	2.851	3.098
5.30	2.261	2.503	2.654	2.877	3.129
5.40	2.273	2.520	2.674	2.901	3.160
5.50	2.286	2.537	2.693	2.926	3.190
5.60	2.298	2.553	2.712	2.949	3.220
5.70	2.309	2.568	2.730	2.972	3.248
5.80	2.320	2.583	2.748	2.995	3.277
5.90	2.330	2.598	2.766	3.017	3.304
6.00	2.340	2.612	2.782	3.038	3.331
6.20	2.360	2.639	2.814	3.079	3.383
6.40	2.377	2.664	2.845	3.118	3.433
6.60	2.394	2.687	2.873	3.155	3.481
6.80	2.409	2.709	2.900	3.190	3.527
7.00	2.423	2.730	2.925	3.223	3.571
7.20	2.436	2.749	2.949	3.255	3.613
7.40	2.448	2.767	2.971	3.285	3.653
7.60	2.459	2.784	2.992	3.313	3.691
7.80	2.470	2.799	3.012	3.340	3.728
8.00	2.479	2.814	3.031	3.366	3.763
8.50	2.500	2.847	3.073	3.424	3.845
9.00	2.517	2.875	3.109	3.476	3.918
9.50	2.532	2.898	3.141	3.521	3.983
10.0	2.543	2.919	3.167	3.560	4.042
15.0	2.591	3.009	3.296	3.768	4.378
20.0	2.598	3.026	3.325	3.825	4.490
30.0	2.599	3.030	3.333	3.845	4.539
40.0	2.599	3.030	3.333	3.846	4.545

EXTERNAL LOADING

MARSTON SOIL COEFFICIENTS (C_d) FOR TRENCH CONDUITS	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
WATER LINE REPLACEMENT IN SPRING WOODS S. AREA	WBS No. S-00035-0181-4 PROJECT NO. : G13-165 — TABLE 4 (2 of 2)

PST 8/28/12

APPENDIX 1

PHOTOGRAPHS OF THE PROJECT SITE

PHOTOGRAPHS OF THE PROJECT SITE
ATL PROJECT No.: G13-165 WBS No: S-000035-0181-4
WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA

Looking East On Neuens Road From Gessner

Looking North On Witte Road From Haddington Drive

PHOTOGRAPHS OF THE PROJECT SITE

ATL PROJECT No.: G13-165 WBS No: S-000035-0181-4

WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA

Looking West On Whiteside Lane From Witte Road

Looking East On Long Point Road From Gessner

APPENDIX 2

PIEZOMETER INSTALLATION REPORTS

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA WBS No.: S-000035-0181-4	PIEZOMETER NO.: B-1 (PZ-1)

GEOTECHNICAL CONSULTANT	DESIGN CONSULTANT	
ASSOCIATED TESTING LABORATORIES, INC.	VanDeWiele & Volger, Inc.	CITY OF HOUSTON

COMPLETION DATE: 7-22-13

DRY AUGERED 0 TO 17 FT

WASH BORED _______ TO ________ FT

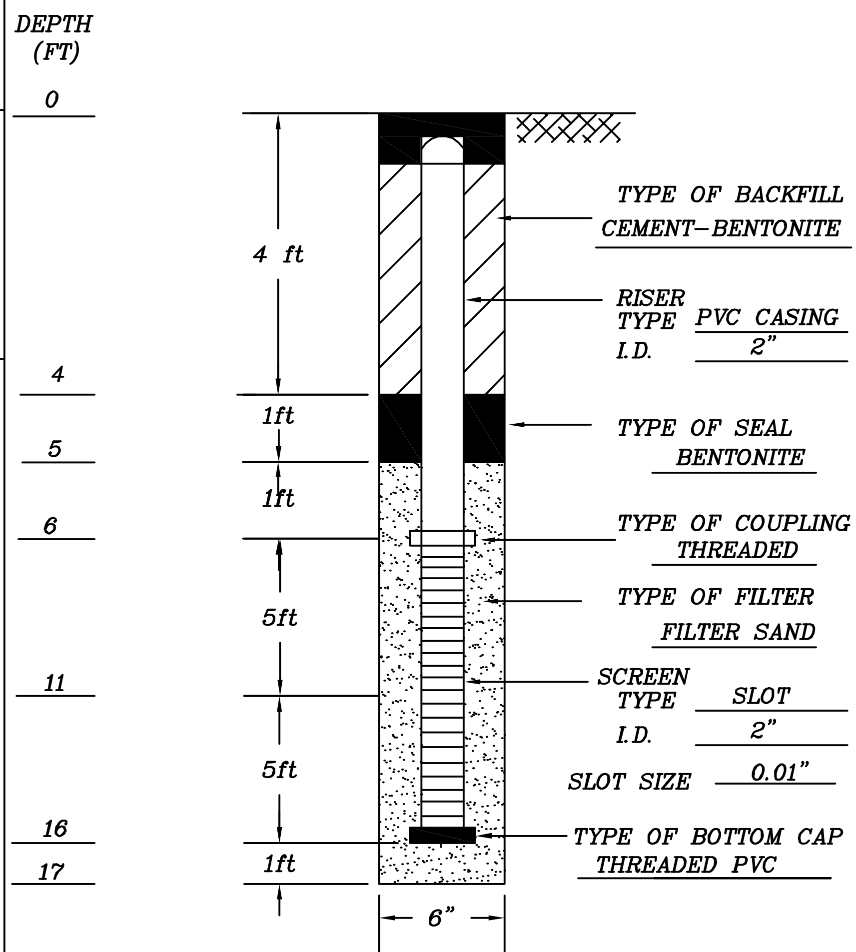
DRILING FLUID: ____________________

DEVELOPMENT DATE: 7-22-13

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

DATE	READING
7-23-13	DRY
7-29-13	DRY
8-22-13	DRY



(NOT TO SCALE)

REMARKS:

NOTES:	DRILLED BY; VAN & SON	STARTED: 7-22-13	ATL job No. G13-165
	LOGGED BY: PV	COMPLETED: 7-22-13	
	CHECKED BY: JITU	APPROVED BY: PST	SHEET 1 OF 3

ASSOCIATED TESTING LABORATORIES, INC.

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA WBS No.: S-000035-0181-4		PIEZOMETER NO.: B-4 (PZ-2)
GEOTECHNICAL CONSULTANT ASSOCIATED TESTING LABORATORIES, INC.	DESIGN CONSULTANT VanDeWiele & Volger, Inc.	CITY OF HOUSTON

COMPLETION DATE: 7-22-13

DRY AUGERED 0 TO 19 FT

WASH BORED ______ TO ______ FT

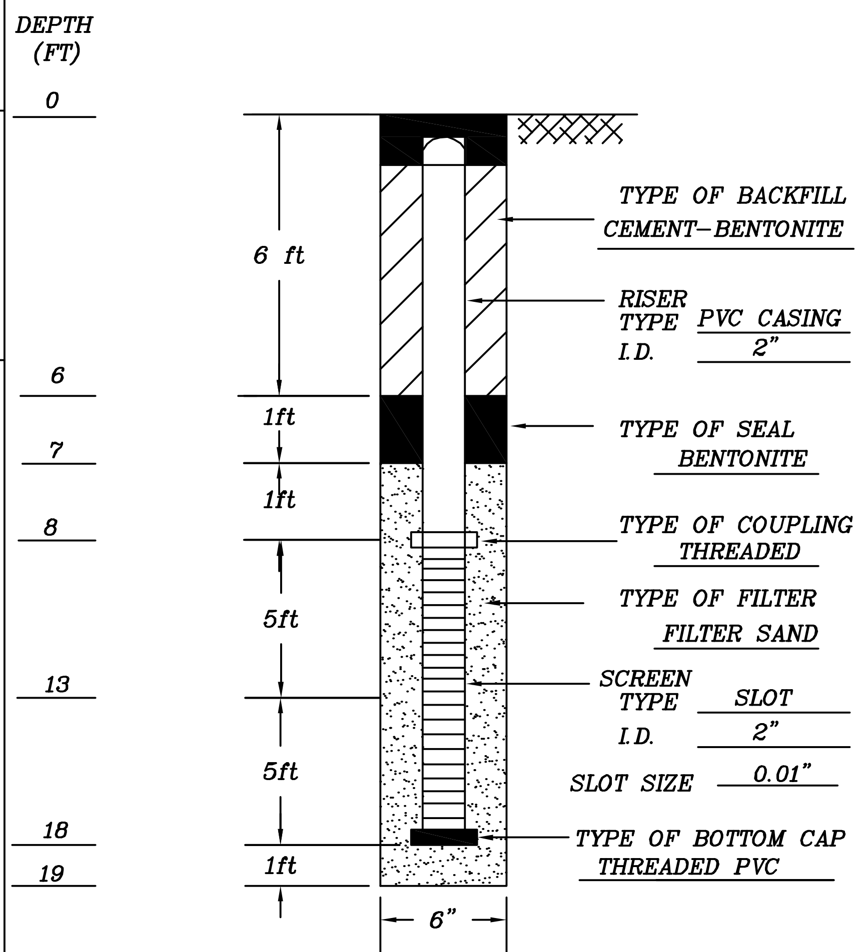
DRILING FLUID: ______

DEVELOPMENT DATE: 7-22-13

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

DATE	READING
7-23-13	DRY
7-29-13	DRY
8-22-13	DRY



(NOT TO SCALE)

REMARKS:

NOTES:	DRILLED BY; VAN & SON	STARTED: 7-22-13	ATL job No. G13-165
	LOGGED BY: PV	COMPLETED: 7-22-13	
	CHECKED BY: JITU	APPROVED BY: PST	SHEET 2 OF 3

ASSOCIATED TESTING LABORATORIES, INC.

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: WATER LINE REPLACEMENT IN SPRING WOODS SOUTH AREA WBS No.: S-000035-0181-4

PIEZOMETER NO.: B-10 (PZ-3)

GEOTECHNICAL CONSULTANT	DESIGN CONSULTANT	
ASSOCIATED TESTING LABORATORIES, INC.	VanDeWiele & Volger, Inc.	CITY OF HOUSTON

COMPLETION DATE: 7-22-13

DRY AUGERED 0 TO 17 FT

WASH BORED ______ TO ______ FT

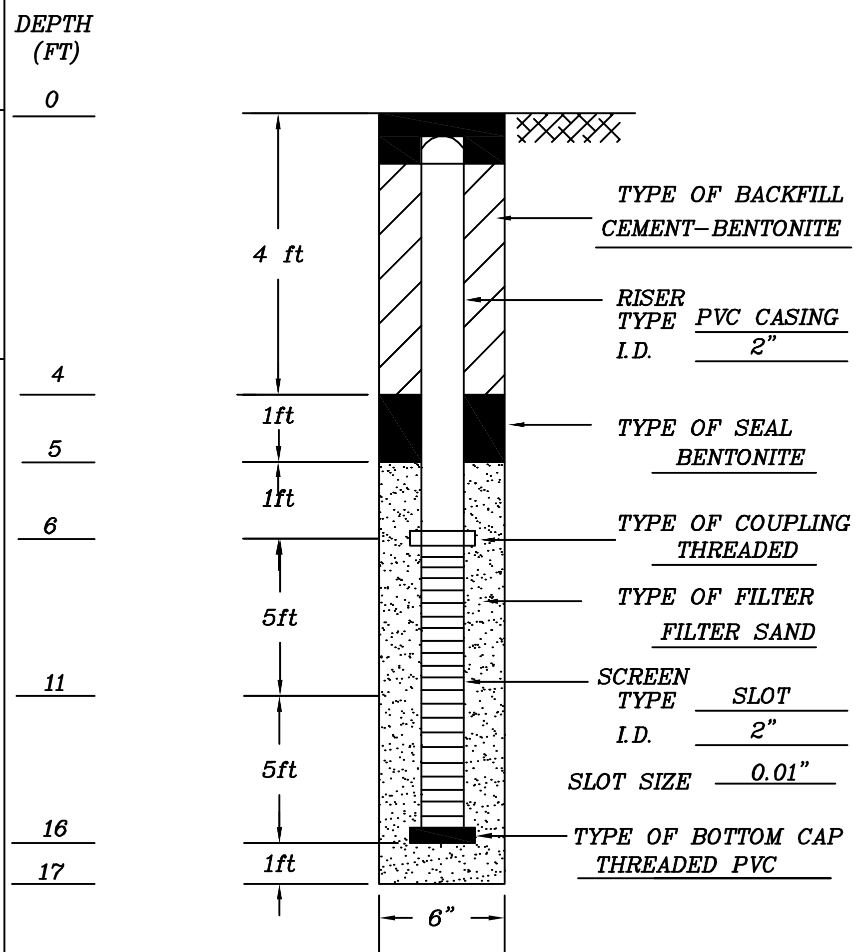
DRILING FLUID: ______

DEVELOPMENT DATE: 7-22-13

METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READING:

DATE	READING
7-23-13	DRY
7-29-13	DRY
8-22-13	DRY



(NOT TO SCALE)

REMARKS:

NOTES:

DRILLED BY;	STARTED:
VAN & SON	7-22-13
LOGGED BY:	COMPLETED:
PV	7-22-13
CHECKED BY:	APPROVED BY:
JITU	PST

ATL job No. G13-165

SHEET 3 OF 3

ASSOCIATED TESTING LABORATORIES, INC.

G13-165

Attention Owner:
Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512) 463-7880 FAX (512) 463-8616
Toll free (800) 803-9202
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department and owner **within 60 days** upon completion of the well.

WELL REPORT

1) OWNER — **A. WELL IDENTIFICATION AND LOCATION DATA**

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	SEC of Neuens Rd at Gessner (pz-1)	Houston	Tx	77080

3) Type of Work ☒ New Well ☐ Reconditioning ☐ Replacement ☐ Deepening

Lat. ° ' " Long. ° ' " Grid # 65-12-5

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell ☐ Rig Supply ☐ Stock or Livestock If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑

6) Drilling Date
Started 7/22/2013
Completed 7/22/2013

Diameter of Hole

Dia. (in)	From (ft)	To (ft)
4	Surface 0	17

7) Drilling Method (check) ☐ Driven ☐ Air Rotary ☐ Mud Rotary ☐ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Hollow Stem Auger ☐ Reverse Circulation ☒ Other dry auger

From (ft)	To (ft)	Description and color of formation material
0	8	SaCl Fill
8	12	ClSa
12	17	SaCl

(Use reverse side of Well Owner's copy, If necessary)

8) Borehole Completion ☐ Open Hole ☐ Straight Wall ☐ Under-reamed ☐ Gravel Packed ☒ Other 9 & 12
Gravel Packed interval from ft. to ft. Size:

Casing, Blank Pipe, and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft) From	To	Gage Casing Screen
2	n	Sch 40 PVC Riser	0	12	
2	n	Sch 40 PVC Screen	12	17	.010

9) Annular Seal Data: i.e. *(from 0 ft to 100 ft #sacks & material 13 cement)*
from 0 ft. to 8 ft. #sacks & material 1 cement
from 8 ft. to 10 ft. #sacks & material .5 bentonite
from ft. to ft. #sacks & material
Method Used
Distance to septic field or other concentrated contamination na ft.
Distance to Property Line ft Method na
Verified: na

10) Surface Completion (If steel cased, leave blank)
☐ Surface Slab Installed ☒ Surface Sleeve Installed ☐ Pitless Adapter Used ☐ Alternative Procedure Used

11) Water Level
Static level dry ft. Date 7/22/2013
Artesian Flow gpm

12) Packers

Type	Depth	Type	Depth
20/40	10-17		

13) Plugged ☐ Well plugged within 48 hours
Casing left in well: na Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	Material used & # Sacks

14) Type Pump
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other na
Depth to pump bowls, cylinder, jet, etc., ft.

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: na gpm with ft. drawdown after hrs.

16) Water Quality
Type of water: Depth of Strata: Was a chemical analysis made? ☐ Yes ☒ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☒ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ☐ Hydrocarbons (i.e. gas, oil, etc.) ☐ Hazardous material/waste contamination encountered ☐ Other (describe)

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

Company or Individual's Name (type or print) Van and Sons Drilling Service Lic. No. 2903M
Address 319 John Alber City Houston State Tx Zip 77076

Signature Licensed Driller/Pump Installer	Date	Signature Apprentice	Date
	8/21/2013		/ /

Attention Owner: Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512) 463-7880 FAX (512) 463-8616
Toll free (800) 803-9202
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department and owner **within 60 days** upon completion of the well.

WELL REPORT

1) OWNER — A. WELL IDENTIFICATION AND LOCATION DATA

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	Witte Rd S. of Neuens Rd (pz-2)	Houston	Tx	77080

Lat. ° ' " Long. ° ' " Grid # 65-12-5

3) Type of Work
☒ New Well ☐ Reconditioning
☐ Replacement ☐ Deepening

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic
☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell
☐ Rig Supply ☐ Stock or Livestock If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑

6) Drilling Date
Started 7/22/2013
Completed 7/22/2013

Diameter of Hole

Dia. (in)	From (ft)	To (ft)
	Surface	
4	0	19

7) Drilling Method (check)
☐ Driven ☐ Air Rotary ☐ Mud Rotary
☐ Bored ☐ Air Hammer ☐ Cable Tool
☐ Jetted ☐ Hollow Stem Auger
☐ Reverse Circulation
☒ Other **dry auger**

From (ft)	To (ft)	Description and color of formation material
0	4	SaCl Fill
4	19	SaCl

(Use reverse side of Well Owner's copy, If necessary)

8) Borehole Completion ☐ Open Hole ☐ Straight Wall
☐ Under-reamed ☐ Gravel Packed ☒ Other 9 & 12
Gravel Packed interval from ft. to ft. Size:

Casing, Blank Pipe, and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
2	n	Sch 40 PVC Riser	0	14	
2	n	Sch 40 PVC Screen	14	19	.010

9) Annular Seal Data: i.e. *(from 0 ft to 100 ft #sacks & material 13 cement)*
from 0 ft. to 10 ft. #sacks & material 1 cement
from 10 ft. to 12 ft. #sacks & material .5 bentonite
from ft. to ft. #sacks & material
Method Used
Distance to septic field or other concentrated contamination na ft.
Distance to Property Line ft Method na
Verified: na

13) Plugged ☐ Well plugged within 48 hours
Casing left in well: na Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	Material used & # Sacks

10) Surface Completion (If steel cased, leave blank)
☐ Surface Slab Installed ☒ Surface Sleeve Installed
☐ Pitless Adapter Used ☐ Alternative Procedure Used

14) Type Pump
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder
☐ Other na
Depth to pump bowls, cylinder, jet, etc., ft.

11) Water Level
Static level dry ft. Date 7/22/2013
Artesian Flow gpm

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: na gpm with ft. drawdown after hrs.

12) Packers

Type	Depth	Type	Depth
20/40	12-19		

16) Water Quality
Type of water: Depth of Strata: Was a chemical analysis made? ☐ Yes ☒ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☒ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ☐ Hydrocarbons (i.e. gas, oil, etc.)
☐ Hazardous material/waste contamination encountered ☐ Other (describe)

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

Company or Individual's Name (type or print) Van and Sons Drilling Service Lic. No. 2903M
Address 319 John Alber City Houston State Tx Zip 77076

Signature	Date	Signature	Date
	8/21/2013		/ /
Licensed Driller/Pump Installer	Date	Apprentice	Date

Attention Owner:
Confidentiality Privilege Notice on reverse side of owner's copy.

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512) 463-7880 FAX (512) 463-8616
Toll free (800) 803-9202
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department and owner **within 60 days** upon completion of the well.

WELL REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	Witte Rd S. of Hanka Dr (pz-3)	Houston	Tx	77080

Lat. ° ' " Long. ° ' " Grid # 65-12-5

3) Type of Work
☒ New Well ☐ Reconditioning ☐ Replacement ☐ Deepening

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Industrial ☐ Irrigation ☐ Injection ☐ Public Supply ☐ De-watering ☐ Testwell ☐ Rig Supply ☐ Stock or Livestock If Public Supply, were plans approved? ☐ Yes ☐ No

5) N↑

6) Drilling Date
Started 7/22/2013
Completed 7/22/2013

Diameter of Hole

Dia. (in)	From (ft)	To (ft)
4	Surface 0	17

7) Drilling Method (check)
☐ Driven ☐ Air Rotary ☐ Mud Rotary ☐ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Hollow Stem Auger ☐ Reverse Circulation ☒ Other **dry auger**

From (ft)	To (ft)	Description and color of formation material
0	4	SaCl Fill
4	17	SaCl

(Use reverse side of Well Owner's copy, If necessary)

8) Borehole Completion ☐ Open Hole ☐ Straight Wall ☐ Under-reamed ☐ Gravel Packed ☒ Other 9 & 12
Gravel Packed interval from ft. to ft. Size:

Casing, Blank Pipe, and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
2	n	Sch 40 PVC Riser	0	12	
2	n	Sch 40 PVC Screen	12	17	.010

9) Annular Seal Data: i.e. *(from 0 ft to 100 ft #sacks & material 13 cement)*
from 0 ft. to 8 ft. #sacks & material 1 cement
from 8 ft. to 10 ft. #sacks & material .5 bentonite
from ft. to ft. #sacks & material
Method Used
Distance to septic field or other concentrated contamination na ft.
Distance to Property Line ft Method na
Verified: na

13) Plugged ☐ Well plugged within 48 hours
Casing left in well: na Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	Material used & # Sacks

10) Surface Completion (If steel cased, leave blank)
☐ Surface Slab Installed ☒ Surface Sleeve Installed ☐ Pitless Adapter Used ☐ Alternative Procedure Used

14) Type Pump
☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder ☐ Other na
Depth to pump bowls, cylinder, jet, etc., ft.

11) Water Level
Static level dry ft. Date 7/22/2013
Artesian Flow gpm

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: na gpm with ft. drawdown after hrs.

12) Packers

Type	Depth	Type	Depth
20/40	10-17		

16) Water Quality
Type of water: Depth of Strata: Was a chemical analysis made? ☐ Yes ☒ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☒ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ☐ Hydrocarbons (i.e. gas, oil, etc.) ☐ Hazardous material/waste contamination encountered ☐ Other (describe)

☐ *I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.*

Company or Individual's Name (type or print) Van and Sons Drilling Service Lic. No. 2903M
Address 319 John Alber City Houston State Tx Zip 77076
Signature [signature] 8/21/2013 Signature / /
Licensed Driller/Pump Installer Date Apprentice Date

613-165

Texas Department of License and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department within 30 days following the plugging of the well.

PLUGGING REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	SEC of Neuens Rd and Gessner	Houston	Tx	77080

3) Owner's Well No. 1 **Long.** ° ' " **Lat.** ° ' " **Grid #** 65-12-5

4) Type of Well ☐ Water ☒ Monitor ☐ Injection ☐ De-Watering

5) N↑

Drill, Pump Installer, or Landowner performing the plugging operations **must** locate and identify the location of the well within a specific grid on a full scale gridded map available from Texas Natural Resource Information Service. The location of the well should be denoted within the grid by placing a corresponding dot in the square to the right. The legal description is optional.

B) HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller	License No.
Eddie VanAntwerp	2903M

7) Drilled 7/22/2013 8) Diameter of hole 4 inches 9) Total depth of well 17 feet.

C. CURRENT PLUGGING DATA

10) Date well plugged 8/19/2013

12) Name of Driller/Pump Installer or Well Owner performing the plugging: Eddie VanAntwerp

License No. 2903M

11) REMOVE ALL REMOVEABLE CASING
Please check box beside the method of plugging used

- ☒ Tremmie pipe cement from bottom to top.
- ☐ Tremmie pipe bentonite from bottom to 2 feet from surface, cement top 2 feet.
- ☐ Pour in 3/8 bentonite chips when standing water in well is less than 100 feet in depth, cement top 2 feet.
- ☐ Large diameter well filled with clay material from top to bottom.

13) CASING AND CEMENTING DATA RELATIVE TO THE PLUGGING OPERATIONS.

CASING LEFT IN WELL

DIAMETER (inches)	FROM (feet)	TO (feet)
2	0	17

CEMENT/BENTONITE PLUG(S) PLACED IN WELL

FROM (feet)	TO (feet)	SACKS
0	17	1.5

COMMENTS

tried to pull well material
could not pull due to lack of exposed pvc
grouted well material in place

D. VALIDATION OF INFORMATION INCLUDED IN FORM

I certify that I plugged this well (or the well was plugged under my supervision) and that all of the statements herein are true and correct. I understand that failure to complete items 1 through 13 will result in the report(s) being returned for completion and resubmitted.

Company or Individual's Name (type or print): Van and Sons Drilling Service, Inc

Address 319 John Alber City Houston State Tx Zip 77076

Signature	Date	Signature	Date
[signature]	8/21/2013		/ /
Licensed Driller/Pump Installer	Date	Apprentice	Date

Texas Department of License and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department within 30 days following the plugging of the well.

PLUGGING REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	Witte Rd S. of Neuens Rd	Houston	Tx	77080

3) Owner's Well No. 2 | **Long.** ° ' " | **Lat.** ° ' " | **Grid #** 65-12-5

4) Type of Well ☐ Water ☒ Monitor ☐ Injection ☐ De-Watering

5) N↑

Drill, Pump Installer, or Landowner performing the plugging operations must locate and identify the location of the well within a specific grid on a full scale gridded map available from Texas Natural Resource Information Service. The location of the well should be denoted within the grid by placing a corresponding dot in the square to the right. The legal description is optional.

B) HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller	License No.
Eddie VanAntwerp	2903M

7) Drilled 7/22/2013 | 8) Diameter of hole 4 inches | 9) Total depth of well 19 feet.

C. CURRENT PLUGGING DATA

10) Date well plugged 8/19/2013

12) Name of Driller/Pump Installer or Well Owner performing the plugging Eddie VanAntwerp

License No. 2903M

13) CASING AND CEMENTING DATA RELATIVE TO THE PLUGGING OPERATIONS.

CASING LEFT IN WELL

DIAMETER (inches)	FROM (feet)	TO (feet)
2	0	19

CEMENT/BENTONITE PLUG(S) PLACED IN WELL

FROM (feet)	TO (feet)	SACKS
0	19	1.5

11) REMOVE ALL REMOVEABLE CASING

Please check box beside the method of plugging used

☒ Tremmie pipe cement from bottom to top.

☐ Tremmie pipe bentonite from bottom to 2 feet from surface, cement top 2 feet.

☐ Pour in 3/8 bentonite chips when standing water in well is less than 100 feet in depth, cement top 2 feet.

☐ Large diameter well filled with clay material from top to bottom.

COMMENTS

tried to pull well material
could not pull due to lack of exposed pvc
grouted well material in place

D. VALIDATION OF INFORMATION INCLUDED IN FORM

I certify that I plugged this well (or the well was plugged under my supervision) and that all of the statements herein are true and correct. I understand that failure to complete items 1 through 13 will result in the report(s) being returned for completion and resubmitted.

Company or Individual's Name (type or print) Van and Sons Drilling Service, Inc

Address 319 John Alber | City Houston | State Tx | Zip 77076

Signature	8/21/2013	Signature	/ /
Licensed Driller/Pump Installer	Date	Apprentice	Date

913-165

Texas Department of License and Regulation

Water Well Driller/Pump Installer Program
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Email address: water.well@license.state.tx.us

This form must be completed and filed with the department within 30 days following the plugging of the well.

PLUGGING REPORT

A. WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name	Address	City	State	Zip
City of Houston Geo Dept	611 Walker Floor 14	Houston	Tx	77002

2) WELL LOCATION

County	Physical Address	City	State	Zip
Harris	Witte Rd S. of Hanka Dr	Houston	Tx	77080

3) Owner's Well No. 3 | Long. ° ' " | Lat. ° ' " | Grid # 65-12-5

4) Type of Well ☐ Water ☒ Monitor ☐ Injection ☐ De-Watering

5) N↑

Drill, Pump Installer, or Landowner performing the plugging operations **must** locate and identify the location of the well within a specific grid on a full scale gridded map available from Texas Natural Resource Information Service. The location of the well should be denoted within the grid by placing a corresponding dot in the square to the right. The legal description is optional.

B) HISTORICAL DATA ON WELL TO BE PLUGGED (if available)

6) Driller: **Eddie VanAntwerp** — License No. **2903M**

7) Drilled 7/22/2013 | 8) Diameter of hole 4 inches | 9) Total depth of well 17 feet.

C. CURRENT PLUGGING DATA

10) Date well plugged: **8/19/2013**

12) Name of Driller/Pump Installer or Well Owner performing the plugging: **Eddie VanAntwerp**

License No. **2903M**

13) CASING AND CEMENTING DATA RELATIVE TO THE PLUGGING OPERATIONS.

CASING LEFT IN WELL

DIAMETER (inches)	FROM (feet)	TO (feet)
2	0	17

CEMENT/BENTONITE PLUG(S) PLACED IN WELL

FROM (feet)	TO (feet)	SACKS
0	19	71.5

11) REMOVE ALL REMOVEABLE CASING
Please check box beside the method of plugging used

☒ Tremmie pipe cement from bottom to top.

☐ Tremmie pipe bentonite from bottom to 2 feet from surface, cement top 2 feet.

☐ Pour in 3/8 bentonite chips when standing water in well is less than 100 feet in depth, cement top 2 feet.

☐ Large diameter well filled with clay material from top to bottom.

COMMENTS

tried to pull well material
could not pull due to lack of exposed pvc
grouted well material in place

D. VALIDATION OF INFORMATION INCLUDED IN FORM

I certify that I plugged this well (or the well was plugged under my supervision) and that all of the statements herein are true and correct. I understand that failure to complete items 1 through 13 will result in the report(s) being returned for completion and resubmitted.

Company or Individual's Name (type or print): **Van and Sons Drilling Service, Inc**

Address: 319 John Alber | City: Houston | State: Tx | Zip: 77076

Signature	Date	Signature	Date
Licensed Driller/Pump Installer	8/21/2013	Apprentice	/ /

APPENDIX 3

BORING LOGS AND KEY TO LOG TERMS AND SYMBOLS

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-1 (PZ-1)

DATE: 7-22-13

SURFACE ELEVATION: 90.05

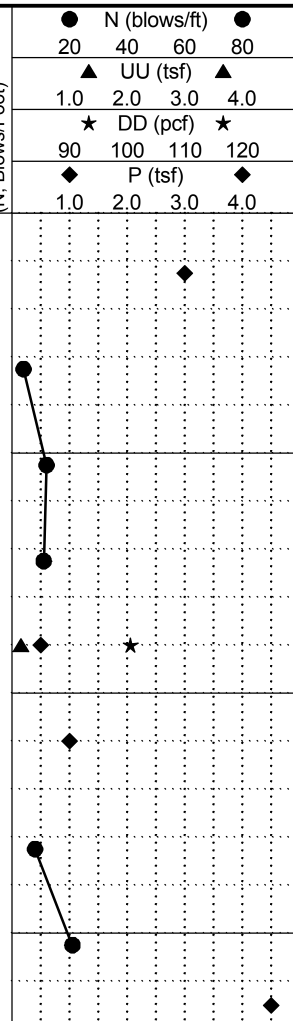
PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

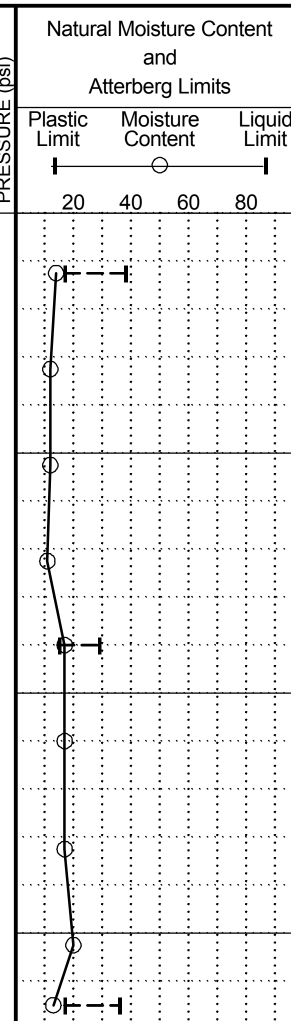
PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Neuens Road
Northing: 13858213.98
Easting: 3064441.35

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		4" Asphalt												
		2" Crushed stone base with shell												
	CL	Fill: Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	3.0						14	38	17	21	52	
	SM	Fill: Silty Sand (SM), loose, non plastic, light gray & tan		4					12					
5		.. medium dense below 4'		12					12					
				11					11					
	CL	Sandy Lean Clay (CL), soft, medium plasticity, light gray & tan, with sa lenses	0.5		101	0.15		0	17	29	15	14	51	
10		.. firm below 10'	1.0						17					
	SM	Silty Sand (SM), loose, non plastic, light gray & tan		8					17					
15		.. medium dense below 14'		21					20					
	CL	Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan	4.5						13	36	17	19		





Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 17'; PZ water level: Dry (7-23-2013); PZ water level: Dry (7-29-2013); PZ water level: Dry (8-22-2013); Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-2

DATE: 7-24-13

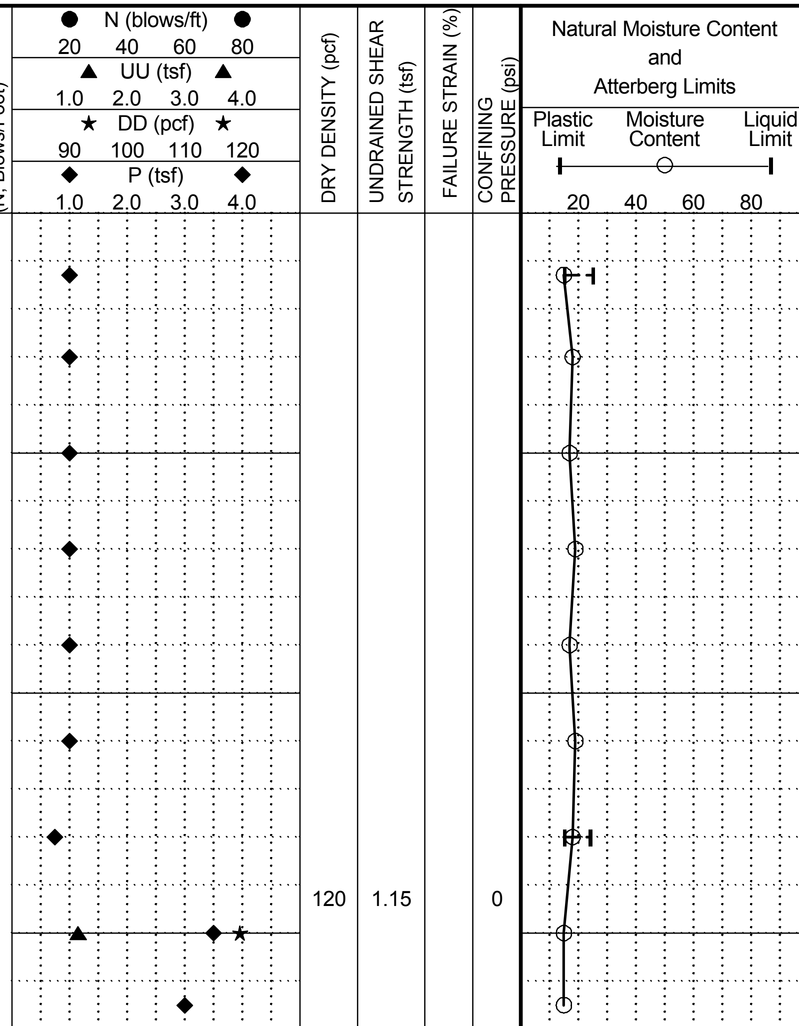
SURFACE ELEVATION: 89.26

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION
Neuens Road
Northing: 13858223.07
Easting: 3064745.25

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3" Asphalt												
		4" Crushed gravel base	1.0						15	25	15	10	51	
	CL	Fill: Sandy Lean Clay (CL), firm, slight plasticity, light gray & tan	1.0						18					
		.. firm, with ferrous nodules below 4'	1.0						17					
5		.. with shells & calcareous nodules below 6'	1.0						19					
	CL	Sandy Lean Clay (CL), firm, slight plasticity, light gray & tan	1.0						17					
10			1.0						19					
		.. firm, with sand lenses below 12'	0.75						18	24	15	9	51	
		.. very stiff below 14'	3.5		120	1.15		0	15					
15			3.0						15					



Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 17' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-3

DATE: 7-24-13

SURFACE ELEVATION: 87.64

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION: Neuens Road
Northing: 13858243.96
Easting: 3065420.09

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	MOISTURE CONTENT (%)	LL	PL	PI	PASSING #200 SIEVE (%)
0		3.5" Asphalt						
		4" Crushed gravel & shell base	2.0	14	31	16	15	61
	CL	Sandy Lean Clay (CL), stiff, medium plasticity, light gray & tan	1.5	14				
		.. with ferrous nodules below 4'	2.0	18				
5		.. with sand seams below 6'	1.5	17				
			2.0	25				
10			1.5	17				
			2.0	17				
		.. very stiff below 14'	3.0	15	37	17	20	54
15			4.5	15				
		.. hard below 18'						

Other column headings: SAMPLES; WATER LEVEL; BLOW COUNT (N, Blows/Foot); N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0; DRY DENSITY (pcf); UNDRAINED SHEAR STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit) 20 40 60 80; ATTERBERG LIMITS(%); ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 18' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-4 (PZ-2)

DATE: 7-22-13

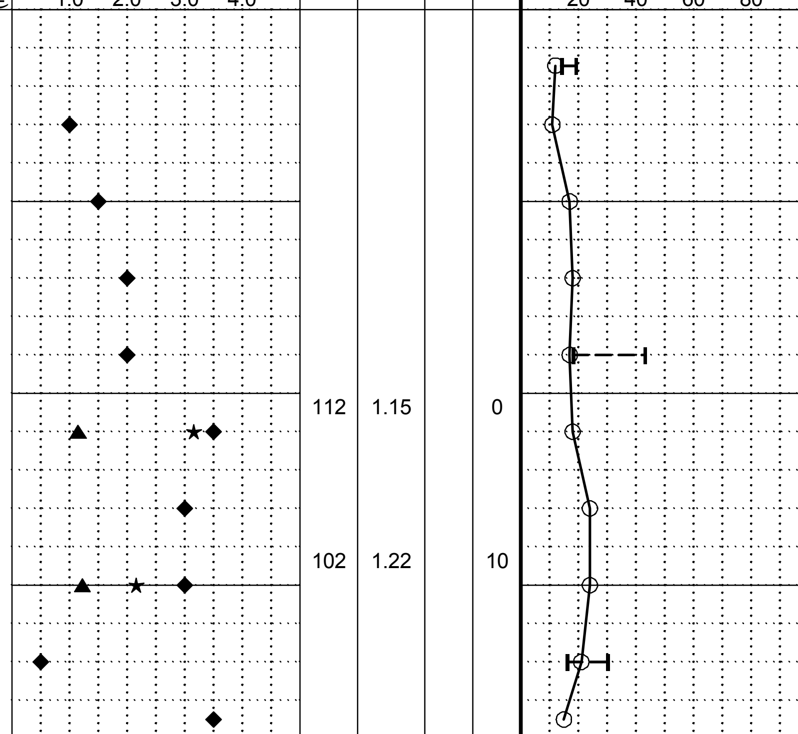
SURFACE ELEVATION: 87.62

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION
Witte Road
Northing: 13858116.72
Easting: 3065866.99

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	PASSING #200 SIEVE (%)
0		8" Asphalt									
		3" Crushed stone base with shell					12	19	14	5	48
	SC SM	Fill: Silty-Clayey Sand (SC-SM), slight plasticity, light gray & tan .. firm below 2'	1.0				11				
5	CL	Sandy Lean Clay (CL), firm, slight plasticity, light gray & tan	1.5				17				
		.. with ferrrous nodules below 6'	2.0				18				
			2.0				17	43	18	25	66
10		.. very stiff below 10'	3.5	112	1.15	0	18				
			3.0				24				
15			3.0	102	1.22	10	24				
		.. soft below 16'	0.5				21	30	16	14	
		.. very stiff below 18'	3.5				15				



Other columns: SAMPLES; WATER LEVEL; BLOW COUNT (N, Blows/Foot); FAILURE STRAIN (%); ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS

Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ▱ Shelby Tube ☰ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 19'; PZ water level: Dry (7-23-2013); PZ water level: Dry (7-29-2013); PZ water level: Dry (8-22-2013) ; Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-5

DATE: 7-24-13

SURFACE ELEVATION: 86.78

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Witte Road
Northing: 13857590.25
Easting: 3065866.99

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	Material Description
0		3" Asphalt
		3.5" Crushed gravel & shell base
	SM	Silty Sand (SM), loose, non plastic, light gray & tan
	CL	Sandy Lean Clay (CL), stiff, slight plasticity, light gray & tan
		.. with sand seams below 4'
5		.. very stiff, with ferrous nodules below 6'
10		
15		

POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
	7					9					
1.5						10	24	15	9		
2.0						18					
3.5						15					
3.0						15					
2.5						31					
3.0						21	48	18	30	70	
4.0		110	1.5		0	20					
4.0						18					

Plot scales: ● N (blows/ft) 20 40 60 80; ▲ UU (tsf) 1.0 2.0 3.0 4.0; ★ DD (pcf) 90 100 110 120; ◆ P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit — 20 40 60 80

Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 17' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-6

DATE: 7-24-13

SURFACE ELEVATION: 86.81

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Witte Road
Northing: 13856978.99
Easting: 3065891.47

MATERIAL DESCRIPTION

- 0 – 0.3': 3.5" Asphalt
- 0.3 – 0.6': 4" Crushed gravel & shell base
- 0.6 – 15': Sandy Lean Clay (CL), stiff, slight plasticity, light gray & tan
  - .. very stiff, with calcareous nodules below 2'
  - .. with ferrous nodules below 4'
  - .. with sand seams below 8'
  - .. very stiff below 14'

USC: CL

Approx. Depth (ft.)	Pocket Penetrometer (P, tsf)	Blow Count (N, Blows/Foot)	Dry Density (pcf)	Undrained Shear Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Passing #200 Sieve (%)	Estimated Angle of Internal Friction (°), Other Tests & Remarks
1	2.0						10	25	15	10	51	
2.5	3.25						12					
4.5	3.75						14					
6.5	3.5						17					
8.5	2.0						17					
10.5	2.0						15	29	15	14	54	
12.5	2.0		118	0.9		0	15					
14.5	2.75						13					

Graph scales: N (blows/ft) 20, 40, 60, 80; UU (tsf) 1.0, 2.0, 3.0, 4.0; DD (pcf) 90, 100, 110, 120; P (tsf) 1.0, 2.0, 3.0, 4.0. Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit): 20, 40, 60, 80.

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
- N - SPT Data (Blows/Ft)
- P - Pocket Penetrometer (tsf)
- T - Torvane (psf)
- Q_u - Unconfined Comp. Strength (tsf)
- DD - Dry Density (pcf)

Notes:
Augered dry to 15' & Hole Grouted after Drilling. Drilled By: Johnson and Sons, Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-7

DATE: 7-24-13
SURFACE ELEVATION: 87.03

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165   BORING TYPE: Auger

LOCATION
Witte Road
Northing: 13856513.24
Easting: 3065910.64

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3.5" Asphalt												
		4" Crushed stone base with shell	2.0						9					
	CL	Sandy Lean Clay (CL), stiff, medium plasticity, light gray & tan	2.0						13	36	17	19	52	
		.. very stiff, with sand seams below 4'	2.5						14					
5		.. with sand pockets below 6'	2.75						15					
		.. with ferrous nodules below 8'	3.0						14					
10			3.0						15	32	16	16	51	
		.. firm below 12'	1.0		103	0.25		0	11					
15	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		18					7					
				21					9					
20				23					9					

Plot legend: N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0. Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 20' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-8

DATE: 7-26-13

SURFACE ELEVATION: 88.05

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165   BORING TYPE: Auger

LOCATION

Witte Road
Northing: 13855994.62
Easting: 3065932.06

MATERIAL DESCRIPTION

USC	Material Description
	3" Asphalt
	4" Crushed gravel & shell base
SM	Silty Sand (SM), non plastic, light gray & tan
CL	Sandy Lean Clay (CL), firm, medium plasticity, light gray & tan .. stiff below 4' .. very stiff, with ferrous nodules below 6'
SC SM	Silty Clayey Sand (SC-SM), firm, slight plasticity, light gray & tan
CL	Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan with ferrous nodules

Depth scale (ft.): 0, 5, 10, 15

Plot scales: N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0; Natural Moisture Content and Atterberg Limits (Plastic Limit – Moisture Content – Liquid Limit) 20 40 60 80

Pocket Penetrometer (P, tsf)	Blow Count (N, Blows/Foot)	Dry Density (pcf)	Undrained Shear Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content (%)	Liquid Limit LL	Plastic Limit PL	Plasticity Index PI	Passing #200 Sieve (%)	Estimated Angle of Internal Friction (°), Other Tests & Remarks
						10					
1.0						17					
2.0						17					
4.0						14	36	17	19	52	
3.5						20					
4.0						18					
3.5		114	1.1		0	14					
1.0						7	20	14	6	35	
3.0						21					

Water Level: Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 17' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-9

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

DATE 7-26-13

SURFACE ELEVATION 88.23

LOCATION
Witte Road
Northing: 13855446.75
Easting: 3065955.14

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		9" Asphalt												
		4" Crushed gravel & shell base												
	SM	Silty Sand (SM), non plastic, light gray & tan							10					
		Sandy Lean Clay (CL), stiff, medium plasticity, dark gray	2.0						14	35	16	19	52	
		.. very stiff below 4'	3.0						17					
5														
		.. light gray & tan below 6'	4.0						16					
		.. with ferrous nodules below 8'	2.75						16					
	CL													
10			3.0						17					
			2.5						15	36	17	19	51	
		.. stiff, light gray & tan below 14'	2.0		113	0.55		0	17					
15														

Chart legend: N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 16' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-10 (PZ-3)

DATE: 7-22-13

SURFACE ELEVATION: 87.74

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Witte Road
Northing: 13854445.28
Easting: 3065996.96

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3" Asphalt												
		6" Crushed gravel & shell base												
	SM	Fill: Silty Sand (SM), non plastic, light gray & tan							7					
	CL	Fill: Sandy Lean Clay (CL), firm, medium plasticity, light gray & tan	1.75						10	24	15	9	51	
	CL	Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	3.0						16					
5		.. with ferrous nodules below 6'	4.0						15					
		.. stiff below 8'	2.5						15					
10		.. very stiff below 10'	3.5						12	25	15	10	52	
			4.0		111	1.17		9	17					
15	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		22					15					
	CL	Sandy Lean Clay (CL), stiff, high plasticity, light gray & tan	2.0						21	46	18	28		

Graph legend: ● N (blows/ft) 20 40 60 80; ▲ UU (tsf) 1.0 2.0 3.0 4.0; ★ DD (pcf) 90 100 110 120; ◆ P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 17'; PZ water level: Dry (7-23-2013); PZ water level: Dry (7-29-2013); PZ water level: Dry (8-22-2013) ; Drilled By: Van & Sons, Logged BY: PV, Checked By: Jitu/pankaj QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-11

DATE: 7-25-13
SURFACE ELEVATION: 85.24

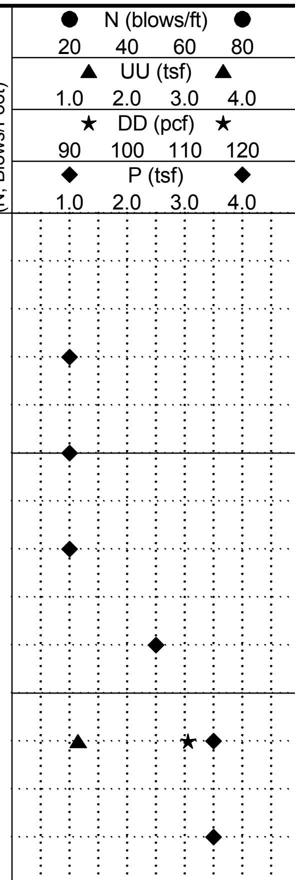
PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

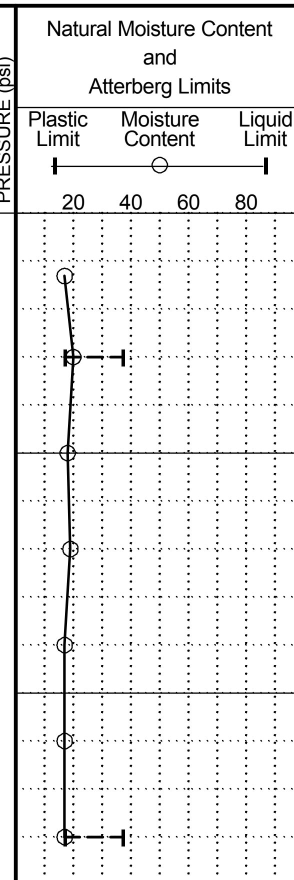
PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Long Point Drive
Northing: 13853997.74
Easting: 3065753.3

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		7.5" Concrete												
	CL	Sandy Lean Clay (CL), medium plasticity, dark gray							17					
		.. firm below 2'	1.0						20	37	17	20	51	
		.. with sand seams below 4'	1.0						18					
5			1.0						19					
		.. very stiff below 8'	2.5						17					
10			3.5		111	1.15		0	17					
			3.5						17	37	17	20	53	





Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ◫ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 14' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-12

DATE 7-25-13

SURFACE ELEVATION 85.34

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Long Point Drive
Northing: 13853990.35
Easting: 3065346.43

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		7" Concrete												
	CL	Sandy Lean Clay (CL), stiff, medium plasticity, light gray & tan	1.5						22	30	16	14	51	
			2.0						20					
		.. with ferrrous nodules below 4'	2.0						19					
5		.. with sand seams below 6'	2.5		109	0.95		0	19					
		.. very stiff, with sand pockets below 8'	3.0						17	49	19	30	54	
10			3.0						17					

Graph legend: N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0. Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80.

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 12' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-13

DATE: 7-25-13

SURFACE ELEVATION: 86.45

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Long Point Drive
Northing: 13853978.3
Easting: 3064658.36

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		8.5" Concrete												
		Sandy Lean Clay (CL), stiff, high plasticity, light gray & tan	2.0						19					
			2.0						24	59	20	39	62	
		.. very stiff below 4'	3.5						17					
5		.. hard below 6'	4.5						15					
	CL		4.5		116	2.05		0	16					
10		.. very stiff, with ferrrous nodules below 10'	4.0						18	50	19	31	51	
			3.5		111	1.93		9	17					
			3.5						19					
15														

Graph scales: N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-14

DATE 7-25-13

SURFACE ELEVATION 88.70

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Timberwood Drive
Northing: 13857291.93
Easting: 3064780.67

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		2.5" Asphalt												
		3" Crushed gravel & shell base							13	25	15	10	52	
	CL	Sandy Lean Clay (CL), slight plasticity, light gray & tan												
		.. hard below 2'	4.5						12					
			4.5						9					
5														
		.. with ferrous nodules below 6'	4.5						10					
			4.5		122	2.25		0	10					
10			4.5						10	40	17	23	51	
			4.5						11					

Chart legend: ● N (blows/ft) ● 20 40 60 80; ▲ UU (tsf) ▲ 1.0 2.0 3.0 4.0; ★ DD (pcf) ★ 90 100 110 120; ◆ P (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-15

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

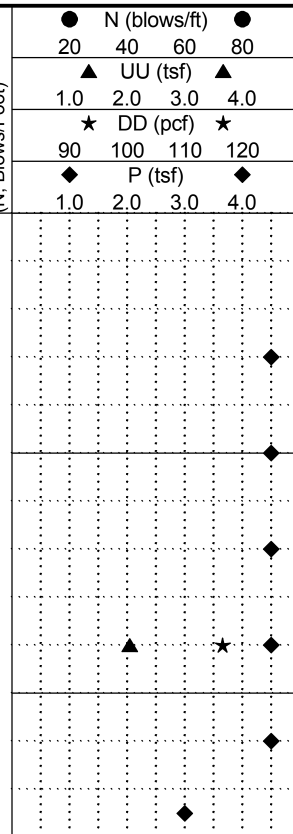
DATE: 7-25-13

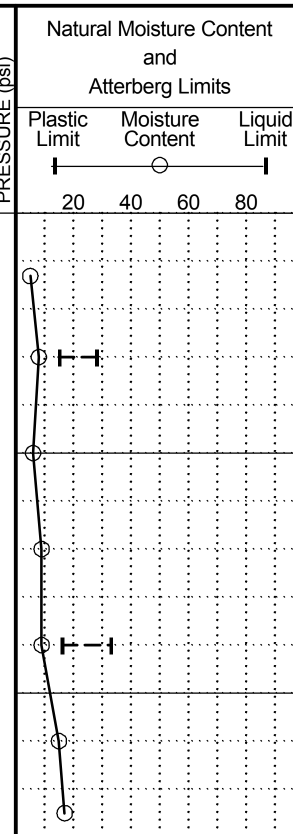
SURFACE ELEVATION: 87.30

LOCATION

Timberwood Drive
Northing: 13857622.2
Easting: 3065139.04

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3" Asphalt												
		4.5" Crushed gravel & shell base							5					
	SM	Silty Sand (SM), non plastic, light gray & tan												
	CL	Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan	4.5						8	28	15	13	51	
		.. with ferrous nodules below 4'	4.5						6					
5			4.5						9					
			4.5		117	2.05		0	9	33	16	17		
10			4.5						15					
		.. very stiff below 12'	3.0						17					





Water Level Initial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 16' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-16

DATE: 7-26-13

SURFACE ELEVATION: 86.92

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165

BORING TYPE: Auger

LOCATION

Hollow Hook Road
Northing: 13857180.04
Easting: 3065455.11

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		6.5" Concrete												
	SC SM	Silty Clayey Silt (SC-SM), firm, slight plasticity, light gray & tan	1.0						16	19	14	5	41	
	CL	Sandy Lean Clay (CL), hard, high plasticity, light gray & tan with calcareous nodules	4.5						11					
		.. with ferrous nodules below 4'	4.5						12					
5			4.5						13					
		.. very stiff below 8'	3.5		110	1.45		0	16					
10			3.0						14	38	17	21		
			4.0						11					

Plot scales: N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0. Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80.

Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-17

DATE: 7-26-13

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

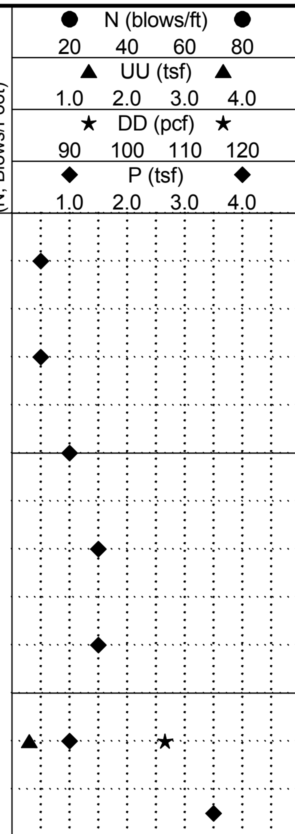
SURFACE ELEVATION: 87.89

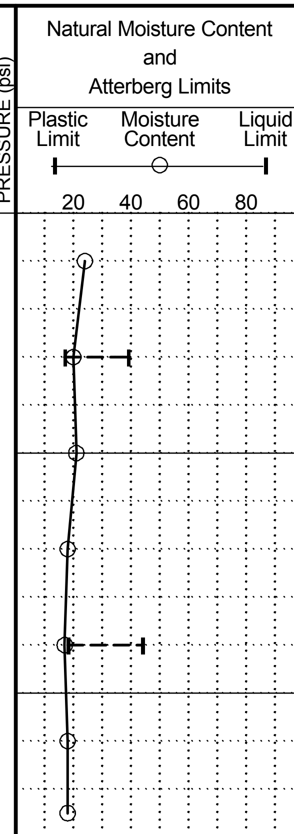
PROJECT NO.: G13-165   BORING TYPE: Auger

LOCATION

Timberoak Dr.(E)
Northing: 13856987.93
Easting: 3064546.2

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	CL	Sandy Lean Clay (CL), soft, high plasticity, light gray & tan with calcareous nodules	0.5						24					
		.. with sand seams below 2'	0.5						20	39	17	22	52	
		.. firm below 4'	1.0						21					
5		.. stiff below 6'	1.5						18					
			1.5						17	44	18	26		
10		.. firm, with sand pockets below 10'	1.0		107	0.3		0	18					
		.. very stiff below 12'	3.5						18					





Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
- N - SPT Data (Blows/Ft)
- P - Pocket Penetrometer (tsf)
- T - Torvane (psf)
- Q_u - Unconfined Comp. Strength (tsf)
- DD - Dry Density (pcf)

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-18

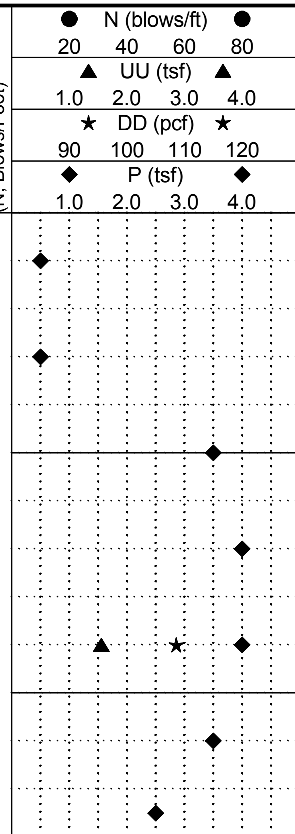
DATE: 7-25-13
SURFACE ELEVATION: 87.13

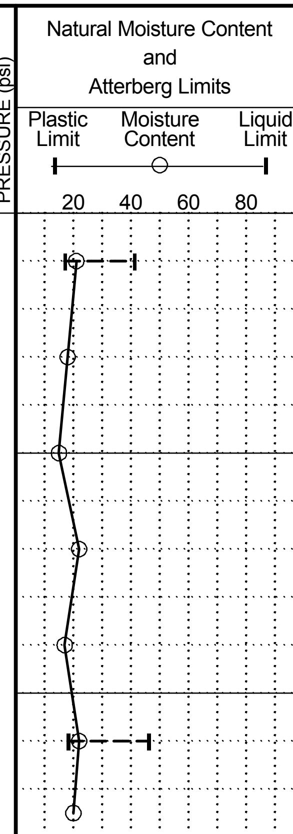
PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION
Timberoak Dr.(E)
Northing: 13856993.65
Easting: 3064952.87

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	CL	Sandy Lean Clay (CL), soft, high plasticity, light gray & tan	0.5						21	41	17	24	66	
2		.. with sand seams below 2'	0.5						18					
4		.. very stiff below 4'	3.5						15					
6		.. with ferrous nodules below 6'	4.0						22					
8			4.0		109	1.55		0	17					
10			3.5						22	46	18	28		
12			2.5						20					





Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-19

DATE: 7-23-13

SURFACE ELEVATION: 88.18

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION: Haddington Dr.
Northing: 13856683.05
Easting: 3064569.13

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		1" Asphalt												
		8" Cement stabilized shell base	1.0						18					
	CL	Sandy Lean Clay (CL), firm, medium plasticity, light gray & tan .. soft below 2'	0.5						17	30	16	14	51	
		.. very stiff below 4'	4.0						14					
5		.. with ferrrous nodules below 6'	4.0						16					
		.. stiff below 8'	2.5		111	0.95		0	14					
10		.. firm below 10'	1.0						8					
	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		15					14				15	
15	CL	Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan			116	2.6		10	16					
									16					

Graph scales: N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 17' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-20

DATE: 7-23-13

SURFACE ELEVATION: 87.95

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Haddington Dr.
Northing: 13856711.1
Easting: 3065200.53

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		5.5" Concrete												
		Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan	4.5						6					
			4.5						5	30	16	14	56	
			4.5						8					
5														
	CL	.. with calcareous nodules below 6'	4.5						8					
		.. with ferrrous nodules below 8'	4.5		122	2.25		0	11					
10			4.5						11	34	16	18		

Graph legend: ● N (blows/ft) 20 40 60 80; ▲ UU (tsf) 1.0 2.0 3.0 4.0; ★ DD (pcf) 90 100 110 120; ◆ P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 12' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-21

DATE: 7-23-13

SURFACE ELEVATION: 86.87

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

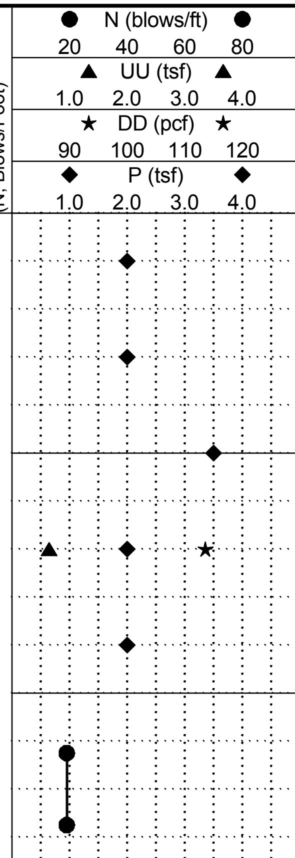
PROJECT NO.: G13-165 BORING TYPE: Auger

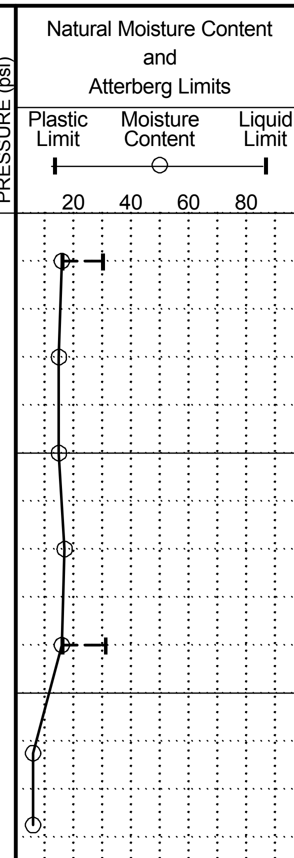
LOCATION

Haddington Dr.
Northing: 13856712.93
Easting: 3065525.22

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	CL	Sandy Lean Clay (CL), stiff, medium plasticity, light gray & tan	2.0						16	30	16	14	60	
		.. with sand seams below 2'	2.0						15					
		.. very stiff below 4'	3.5						15					
5		.. stiff, with sand pockets below 6'	2.0		114	0.65		0	17					
		.. with ferrous nodules below 8'	2.0						16	31	16	15		
10	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		19					6				18	
				19					6					





Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 13.5' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-22

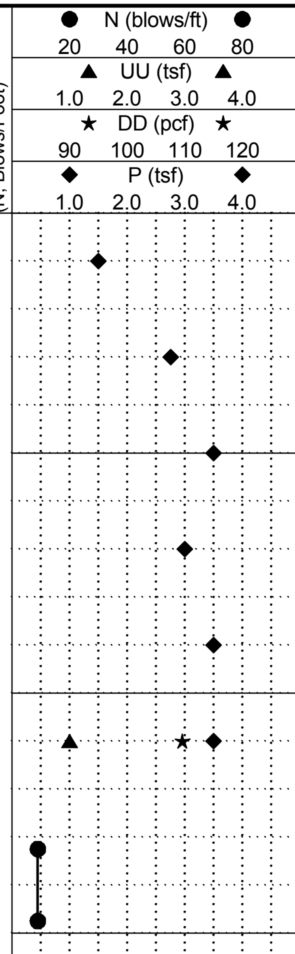
DATE: 7-30-13
SURFACE ELEVATION: 88.06

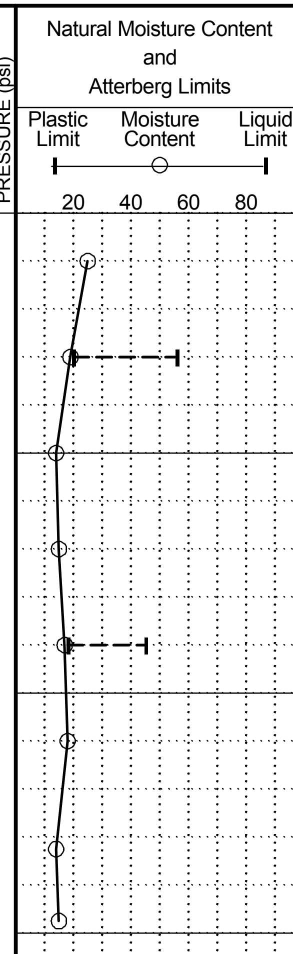
PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION
Warwana Road
Northing: 13856390.84
Easting: 3064584.04

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	Shelby Tube			5" Asphalt	1.5						25					
				6" Crushed shell base												
	Shelby Tube	CH		Sandy Fat Clay (CH), stiff, high plasticity, light gray & tan .. firm below 2'	2.75						19	56	20	36	67	
	Shelby Tube				3.5						14					
5	Shelby Tube			.. with ferrrous nodules below 6'	3.0						15					
	Shelby Tube	CL		Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	3.5						17	45	18	27	59	
10	Shelby Tube				3.5		110	1.0		0	18					
	SPT	SM		Silty Sand (SM), loose, non plastic, light gray & tan		9					14					
	SPT					9					15					
15																





Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ▱ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 15.5' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-23

DATE: 7-30-13

SURFACE ELEVATION: 87.40

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165

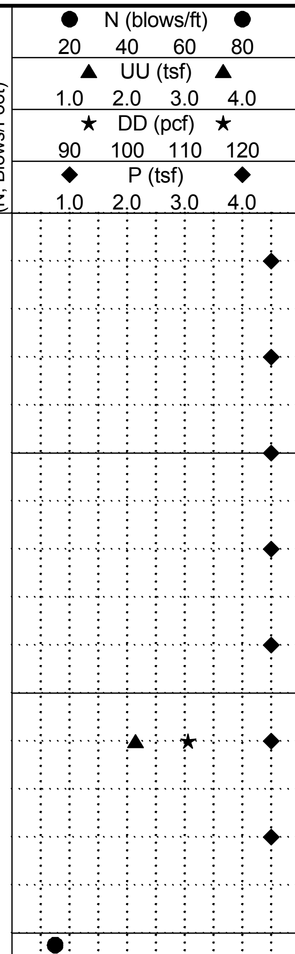
BORING TYPE: Auger

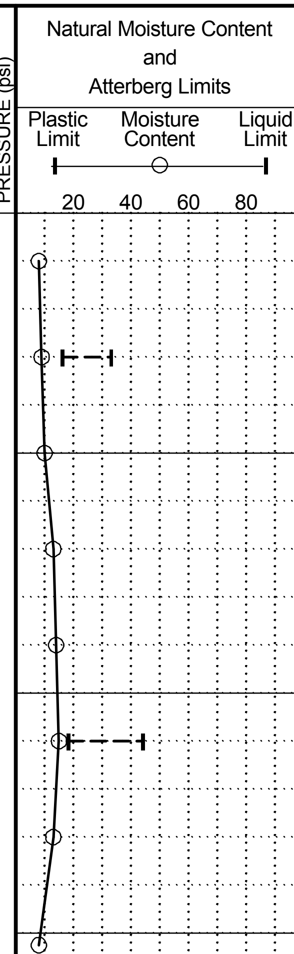
LOCATION

Warwana Road
Northing: 13856403.07
Easting: 3065472.69

MATERIAL DESCRIPTION

DEPTH (ft.)	SAMPLES	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	Shelby Tube		4" Asphalt	4.5						8					
			7" Crushed gravel & shell base												
		CL	Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan .. with ferrous nodules below 6'	4.5						9	33	16	17	57	
				4.5						10					
5				4.5						13					
				4.5						14					
10				4.5		111	2.15		0	15	44	18	26	53	
			.. stiff, with sand seams below 12'	4.5						13					
15	SPT	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		15					8					





Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼

Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ▱ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 15.5' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

HCFCD G13-165 WLR IN SPRING WOODS AREA.GPJ HCFCD.GDT 9/6/13

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-24

DATE: 7-29-13

SURFACE ELEVATION: 88.12

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

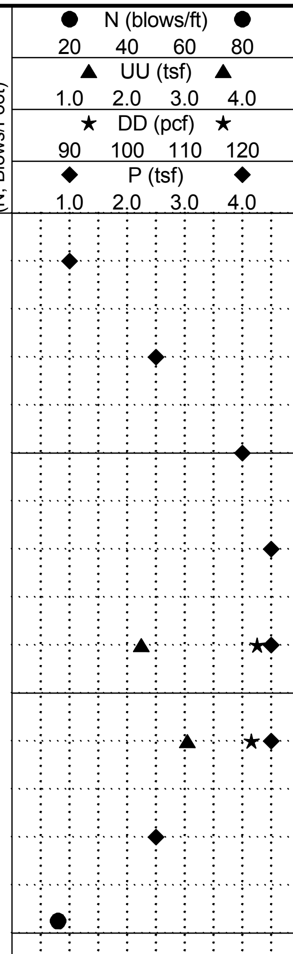
PROJECT NO.: G13-165

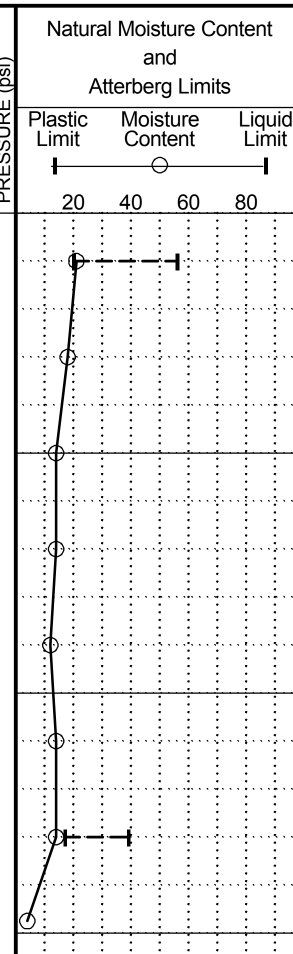
BORING TYPE: Auger

LOCATION

Briarwind Lane
Northing: 13856107.32
Easting: 3064829.81

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3.5" Asphalt	1.0						21	56	20	36	59	
		7" Crushed stone base												
	CH	Sandy Fat Clay (CH), firm, high plasticity, light gray & tan .. very stiff below 2'	2.5						18					
			4.0						14					
5		.. with ferrous nodules below 6'	4.5						14					
	CL	Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5		123	2.25		0	12					
10		.. with ferrous nodules below 10'	4.5		122	3.05		8	14					
		.. very stiff below 12'	2.5						14	39	17	22		
15	SP SM	Poorly Graded Sand With Silt (SP-SM), medium dense, non plastic, light gray & tan		16					4				6	





Water Level Initial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 15.5' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-25

DATE: 7-29-13

SURFACE ELEVATION: 88.00

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

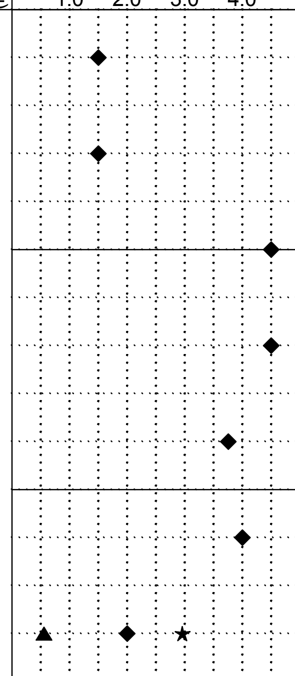
PROJECT NO.: G13-165

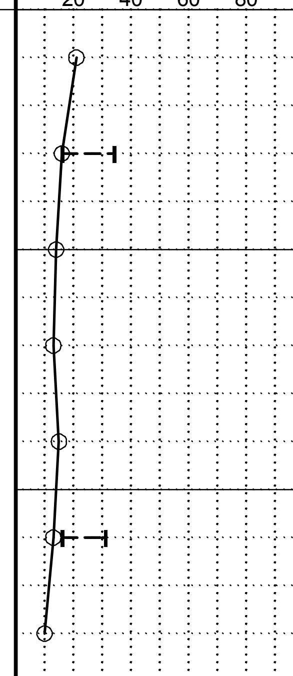
BORING TYPE: Auger

LOCATION

Briarwind Lane
Northing: 13856091.59
Easting: 3065304.91

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		4" Asphalt	1.5						21					
		7" Crushed gravel & shell base												
	CL	Sandy Lean Clay (CL), stiff, medium plasticity, light gray & tan .. with sand seams below 2'	1.5						16	34	16	18	60	
		.. hard below 4'	4.5						14					
5														
		.. with ferrous nodules below 6'	4.5						13					
		.. very stiff below 8'	3.75						15					
10			4.0						13	31	16	15	52	
		.. stiff below 12'	2.0		110	0.55		0	10					





Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 14' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-26

DATE: 7-23-13

SURFACE ELEVATION: 88.31

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

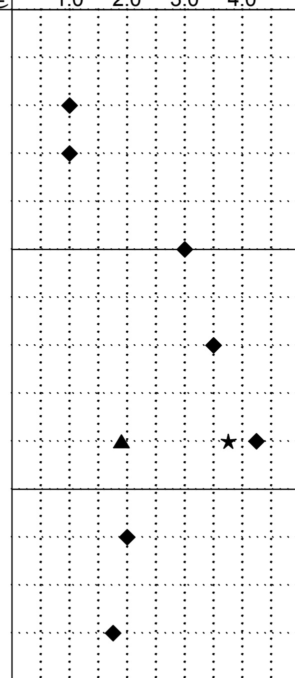
PROJECT NO.: G13-165 BORING TYPE: Auger

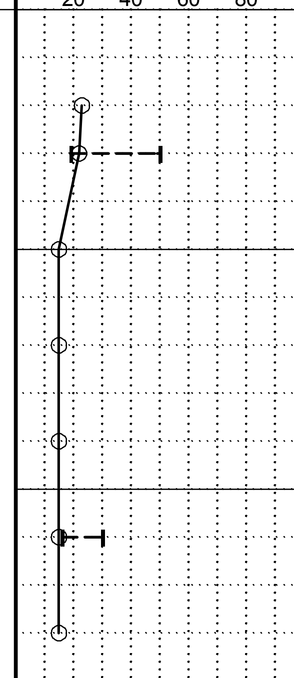
LOCATION

Lazy Oaks St.
Northing: 13855756.09
Easting: 3064612.48

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)
0		6" Asphalt									
		6" Stabilized shell base									
	CH	Sandy Fat Clay (CH), firm, high plasticity, light gray & tan	1.0				23				
			1.0				22	50	19	31	56
		.. very stiff, with ferrous nodules below 4'	3.0				15				
5											
		.. with ferrous nodules below 6'	3.5				15				
		.. very stiff below 8'	4.25	118	1.9	0	15				
10	CL	Sandy Lean Clay (CL), stiff, medium dense, light gray & tan	2.0				15	30	16	14	54
		.. firm, with clayey sand seams below 12'	1.75				15				





Water Level Intial: After Drilling: 24 Hrs:
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 14' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-27

DATE: 7-23-13

SURFACE ELEVATION: 88.52

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

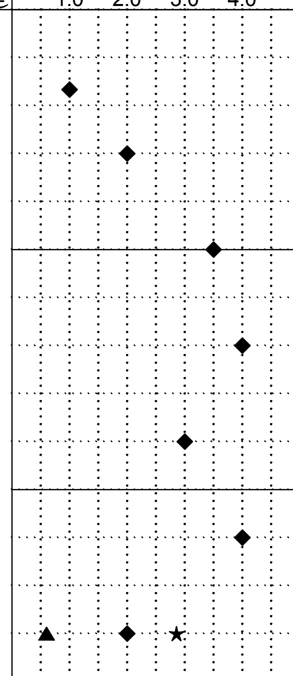
PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

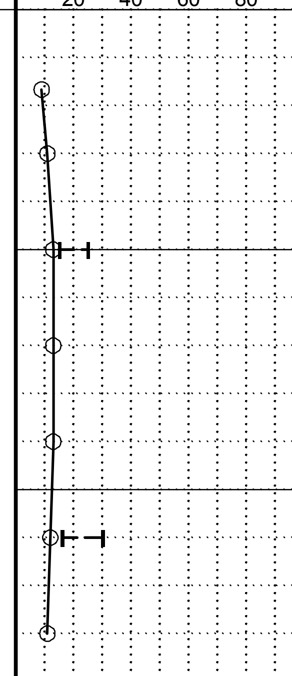
Lazy Oaks St.
Northing: 13855767.8
Easting: 3065170.06

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		6.5" Asphalt												
		9.5" Crushed gravel & shell base												
	CL	Sandy Lean Clay (CL), firm, slight plasticity, light gray & tan	1.0						9					
		.. stiff below 2'	2.0						11					
		.. very stiff below 4'	3.5						13	25	15	10	51	
5		.. with calcareous nodules below 6'	4.0						13					
		.. with ferrous nodules below 8'	3.0						13					
10			4.0						12	30	16	14	52	
		.. stiff below 12'	2.0		109	0.6		0	11					

● N (blows/ft) ● 20 40 60 80
▲ UU (tsf) ▲ 1.0 2.0 3.0 4.0
★ DD (pcf) ★ 90 100 110 120
◆ P (tsf) ◆ 1.0 2.0 3.0 4.0



Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80



Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ◫ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 14' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-28

DATE: 7-30-13

SURFACE ELEVATION: 88.70

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

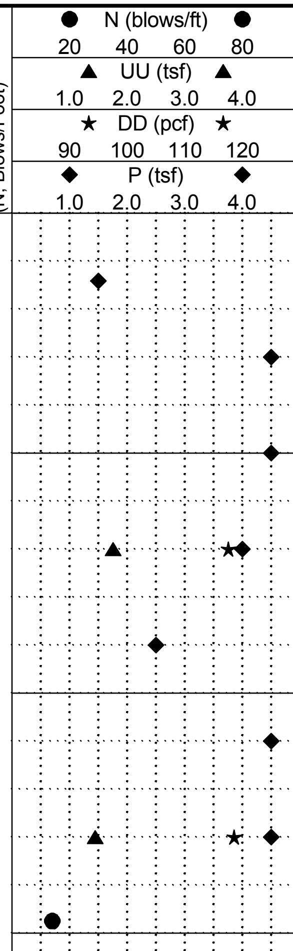
PROJECT NO.: G13-165   BORING TYPE: Auger

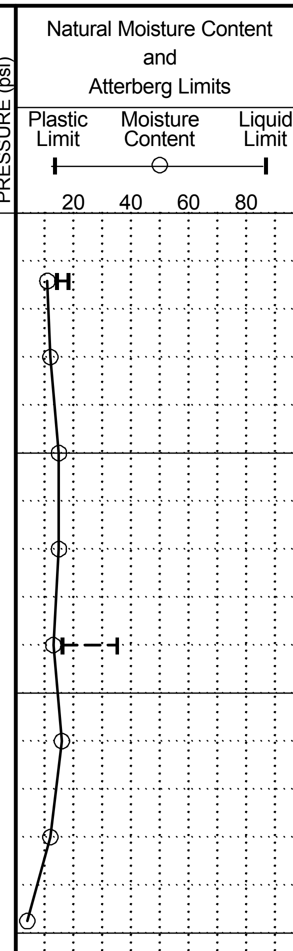
LOCATION

Lazy Oaks St.
Northing: 13855773.91
Easting: 3065575.32

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		6" Asphalt												
		4" Crushed gravel & shell base												
	SC SM	Silty Clayey Sand (SC-SM), stiff, slight plasticity, light gray & tan	1.5						11	18	14	4	37	
	CL	Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan	4.5						12					
			4.5						15					
5		.. very stiff, with sand seams below 6'	4.0		118	1.75		0	15					
		.. with sand pockets below 8'	2.5						13	35	16	19		
10		.. hard below 10'	4.5						16					
			4.5		119	1.45		9	12					
15	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		14					4					





Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 15.5' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-29

DATE: 7-30-13

SURFACE ELEVATION: 87.91

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

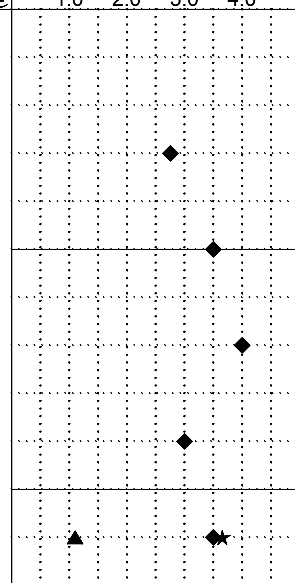
Hazelhurst Drive
Northing: 13855182.42
Easting: 3064640.47

MATERIAL DESCRIPTION

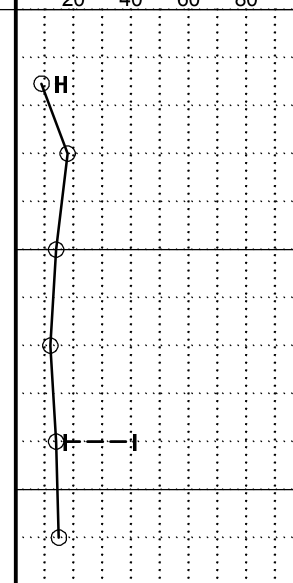
USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
	2" Asphalt												
	11" Stabilized shell base												
SM	Silty Sand (SM), non plastic, light gray & tan							9	17	14	3	43	
CL	Sandy Lean Clay (CL), very stiff, high plasticity, light gray & tan	2.75						18					
	.. with ferrous nodules below 6'	3.5						14					
		4.0						12					
	.. with sand seams below 8'	3.0						14	41	17	24		
		3.5		117	1.1		0	15					

DEPTH (ft.): 0, 5, 10

N (blows/ft): 20 40 60 80
UU (tsf): 1.0 2.0 3.0 4.0
DD (pcf): 90 100 110 120
P (tsf): 1.0 2.0 3.0 4.0



Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80



Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 12' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-30

DATE: 7-30-13

SURFACE ELEVATION: 88.83

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165   BORING TYPE: Auger

LOCATION
Hazelhurst Drive
Northing: 13855190.71
Easting: 3065120.72

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		4" Asphalt												
		7" Crushed gravel & shell base							3					
	SM	Silty Sand (SM), dense, non plastic, light gray & tan		31					4				29	
4–5	CL	Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	4.5						11	48	18	30	51	
		.. with ferrous nodules below 6'	4.5						11					
			4.5						10					
10			4.5		121	2.15		0	11					
			4.5						10	36	17	19		
15		.. very stiff below 14'	2.75						25					

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 15' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-31

DATE: 7-29-13

SURFACE ELEVATION: 88.17

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Whiteside Lane
Northing: 13854929.32
Easting: 3064922.37

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	Material Description	Pocket Penetrometer (P, tsf)	Blow Count (N, Blows/Foot)	Dry Density (pcf)	Undrained Shear Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content (%)	Liquid Limit LL	Plastic Limit PL	Plasticity Index PI	Passing #200 Sieve (%)	Estimated Angle of Internal Friction (°), Other Tests & Remarks
0		4" Asphalt												
		6" Crushed gravel & shell base												
	CL	Sandy Lean Clay (CL), stiff, high plasticity, light gray & tan	2.0						17	35	16	19	52	
		.. with sand seams below 2'	1.75						18					
		.. very stiff, with ferrous nodules below 4'	4.0						13					
5			3.5						13	38	17	21		
			4.0		114	1.1		0	14					
10			3.75						18					

Chart legend: N (blows/ft) 20 40 60 80; UU (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit — 20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT Shelby Tube Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 12' & Hole Grouted after Drilling. Drilled By: Johnson and Sons ,
Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-32

DATE: 7-29-13

SURFACE ELEVATION: 88.28

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

Whiteside Lane
Northing: 13854939.41
Easting: 3065419.76

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION
0 – 0.33		4" Asphalt
0.33 – 1		5" Crushed gravel & shell base
1 – 2	SM	Silty Sand (SM), non plastic, light gray & tan
2 – 12	CL	Sandy Lean Clay (CL), hard, high plasticity, light gray & tan .. with ferrous nodules below 6'

POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
						5					
4.5						13	42	18	24	52	
4.5						11					
4.5						10					
4.5						19	39	17	22		
4.5		120	2.15		0	9					

Chart scales: ● N (blows/ft) ● 20 40 60 80; ▲ UU (tsf) ▲ 1.0 2.0 3.0 4.0; ★ DD (pcf) ★ 90 100 110 120; ◆ P (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 12' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-33

DATE: 7-29-13

SURFACE ELEVATION: 88.14

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

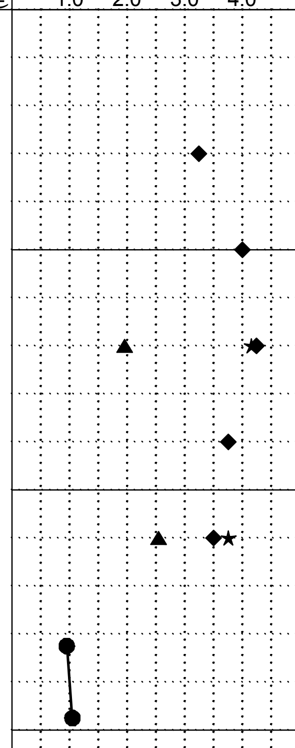
PROJECT NO.: G13-165 BORING TYPE: Auger

LOCATION

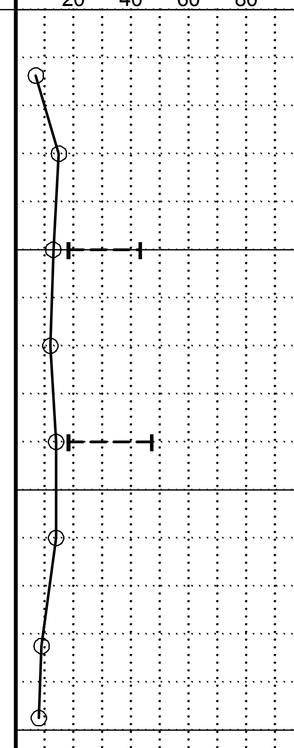
Witte Road
Northing: 13854948.08
Easting: 3065946.07

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3" Asphalt												
		6" Crushed gravel & shell base												
	SM	Silty Sand (SM), non plastic, dark gray							7					
	CL	Sandy Lean Clay (CL), hard, high plasticity, light gray & tan	3.25						15					
		.. tan & light gray below 4'	4.0						13	43	18	25	52	
5														
		.. with ferrous nodules below 6'	4.25		122	1.95		0	12					
			3.75						14	47	18	29		
10			3.5		118	2.54		8	14					
	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		19					9					
				21					8					
15														

● N (blows/ft) ● 20 40 60 80
▲ UU (tsf) ▲ 1.0 2.0 3.0 4.0
★ DD (pcf) ★ 90 100 110 120
◆ P (tsf) ◆ 1.0 2.0 3.0 4.0



Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80



Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 15.5' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-34

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

DATE: 7-29-13

SURFACE ELEVATION: 88.41

LOCATION

Longhorn Road
Northing: 13854479.96
Easting: 3064883.07

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		7" Asphalt												
		5" Crushed gravel base												
	SC SM	Silty Clayey Sand (SC-SM), slight plasticity, light gray & tan							4	19	14	5	41	
			4.5						8					
	CL	Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan												
		.. with ferrous nodules below 4'	4.5						12					
5														
		.. with calcareous nodules below 6'	4.5						12					
			4.5						17					
10			3.5		109	1.0		0	13					
			2.75						12	30	16	14	51	

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-35

DATE: 7-30-13

SURFACE ELEVATION: 87.55

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

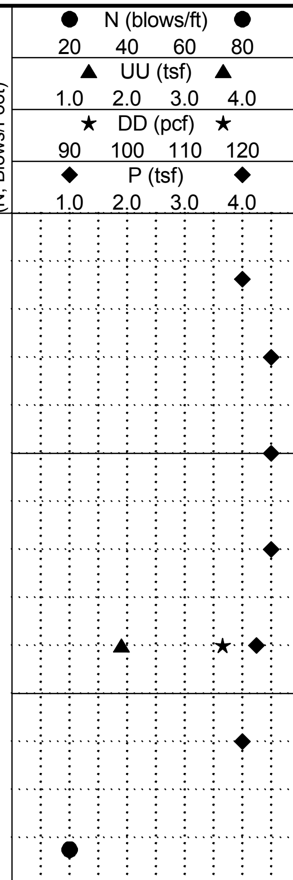
PROJECT NO.: G13-165 BORING TYPE: Auger

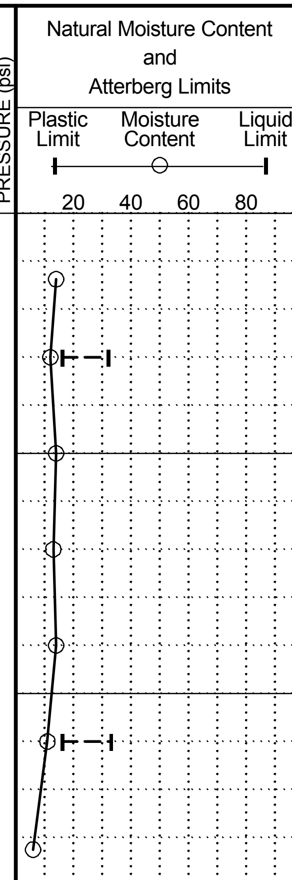
LOCATION

Hanka Drive
Northing: 13854664.97
Easting: 3065520.22

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		3" Asphalt												
		6" Crushed gravel & shell base	4.0						14					
	CL	Sandy Lean Clay (CL), very stiff, medium plasticity, light gray & tan												
		.. hard, with ferrous nodules below 2'	4.5						12	32	16	16	51	
5			4.5						14					
			4.5						13					
		.. very stiff below 8'	4.25		117	1.9		0	14					
10			4.0						11	33	16	17		
	SM	Silty Sand (SM), medium dense, non plastic, light gray & tan		20					6				23	





Water Level Initial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 14' & Hole Grouted after Drilling. Drilled By: Johnson and Sons ,
Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-36

DATE: 7-30-13

SURFACE ELEVATION: 89.32

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165

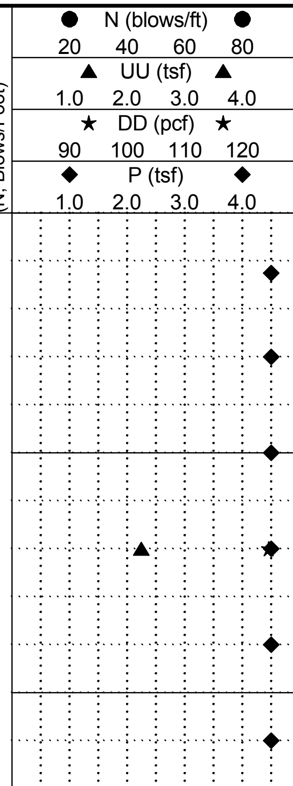
BORING TYPE: Auger

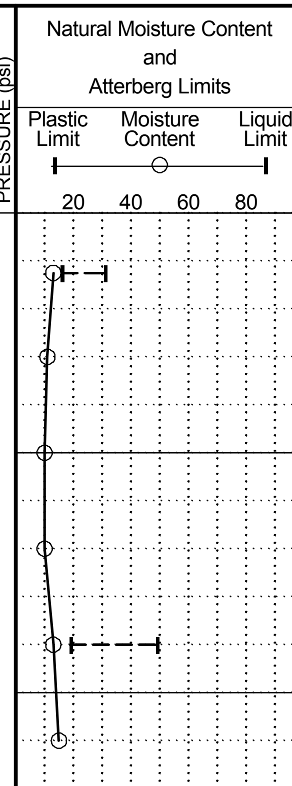
LOCATION

Timberoak Drive
Northing: 13856816.46
Easting: 3061683.51

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		6" Concrete												
	CL	Sandy Lean Clay (CL), hard, medium plasticity, light gray & tan	4.5						13	31	16	15	69	
		.. with calcareous nodules below 2'	4.5						11					
5		.. with ferrous nodules below 4'	4.5						10					
			4.5		125	2.25		0	10					
			4.5						13	49	19	30	67	
10			4.5						15					





Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ◪ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 12' & Hole Grouted after Drilling. Drilled By: Johnson and Sons ,
Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-37

PROJECT: Water Line Replacement in Spring Woods Area
WBS No.: S-000035-0181-4

PROJECT NO.: G13-165 BORING TYPE: Auger

DATE: 7-30-13

SURFACE ELEVATION: 87.87

LOCATION

Haddington Drive (W)
Northing: 13856551.32
Easting: 3062844.37

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER (P, tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNDRAINED SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		7.5" Concrete												
		3" Crushed stone base with shell												
	SC SM	Silty Clayey Sand (SC-SM), slight plasticity, light gray & tan							5	20	14	6	42	
	CL	Sandy Lean Clay (CL), hard, slight plasticity, light gray & tan	4.5						8					
		.. with ferrous nodules below 4'	4.5						9					
5			4.5		126	2.25		0	9					
			4.5						9					
10			4.5		118	2.86		8	11					
			4.5						8	23	15	8		

Graph scales: ● N (blows/ft) 20 40 60 80; ▲ UU (tsf) 1.0 2.0 3.0 4.0; ★ DD (pcf) 90 100 110 120; ◆ P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Intial: ∇ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: Dry, After Drilling: Dry

Sample Key: ☒ SPT ▱ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered dry to 13' & Hole Grouted after Drilling. Drilled By: Johnson and Sons , Logged BY: PV, Checked By: Jitu/pankaj, QC/QA By: PST

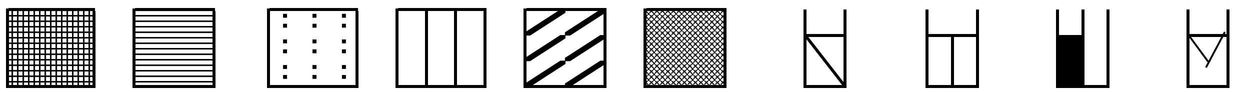
KEY TO LOG TERMS AND SYMBOLS

SOIL TYPE

SAMPLER TYPE

ROCK — GRAVEL — SAND — SILT — CLAY — PEAT — NO SAMPLE — AUGER SAMPLE — SHELBY TUBE — SPLIT SPOON

MODIFIER



STONE — GRAVELY — SANDY — SILTY — CLAYEY — FILL — NO RECOVERY — ROCK CORE — 2" SHELBY TUBE — TXDOT CONE

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS LESS THAN 50% PASSING No. 200 SIEVE	GRAVEL & GRAVELY SOILS LESS THAN 50% PASSING No.4 SIEVE	CLEAN GRAVELS LITTLE OR NO FINES	GW	WELL GRADEED GRAVELS,GRAVELSAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS,GRAVEL SAND MIXTURES WITH LITTLE OR NO FINES
		W/ APPRECIATEBLE FINES	GM	SILTY GRAVELS,GRAVEL SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS,GRAVEL SAND-CLAY MIXTURES
	SANDS MORE THAN 50% PASSING No.4 SIEVE	CLEAN SANDS LITTLE FINES	SW	WELL GRADED SAND,GRAVELY SAND (LITTLE FINES)
			SP	POORLY GRADED SANDS,GRAVELY SAND(L. FINES)
		SANDS WITH APPREA. FINES	SM	SILTY SANDS,SAND-SILT MIXTURES
			SC	CLAYEY SANDS,SAND-CLAY MIXTURES
FINE GRAINED SOILS LESS THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS & VERY FINE SANDS,ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/PI
			CL	INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY, GRAVELY CLAYS,SANDY CLAYS,SILTY CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS,MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS
			OH	ORGANIC CLAYS OF MED TO HIGH PI, ORGANIC SILT
HIGHLY ORGANIC SOIL			FT	PEAT AND OTHER HIGHLY ORGANIC SOILS
UNCLASSIFIED FILL MATERIALS			ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS FILL MATERIALS	

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMP. STRENGTH IN TSF
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.5
FIRM	0.5 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	GREATER THAN 4.0

CONSISTENCY	UNCORR. POCKET PENTROMETER READ.
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.5
FIRM	> 0.50 TO 1.50
STIFF	> 1.50 TO 3.00
VERY STIFF	> 3.0 TO 4.50
HARD	4.5+

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	N-VALUE (BLOWS PER FT)
VERY LOOSE	<4
LOOSE	5-10
MEDIUM DENSE	11-30
DENSE	31-50
VERY DENSE	>50 OR 50+

CLASSIFICATION OF GRANULAR SOILS

U.S.STANDARD SIEVE SIZE(S)

6" 3" 3/4" 4 10 40 200

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152 76.2 19.1 4.76 2.0 0.42 0.074 0.002

GRAIN SIZE IN MM